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GREEK.—XIII.

[*Continued from Vol. VI., p.* 325.]

CONJUGATION (*continued*).

The student must also accustom himself to parse—that is, to assign or declare the several parts of the verbs (and of all words), as well as the grammatical relations they bear to other words. At present, however, we have to do with such exercises as will best aid him to thoroughly master the conjugation of the verb. In regard, then, to the active voice now set forth, as well as to other parts to be hereafter given, he should write down very carefully (and correct what he writes by the paradigm) the several parts of the Greek-English exercise, distinguishing (1) the root, (2) the augment, (3) the tense-stem, (4) the tense-characteristic, (5) the mood-vowel, (6) the tense-stem with the mood-vowel, (7) the person-ending, (8) the tense-stem together with the mood-vowel and the person-ending. Take as an instance ἐβουλεύσατο, *he took counsel.* The word may be divided thus: ἐ-βουλεύ-σ-α-το. Of these elements, βουλευ- is the root; ε is the augment; ε combined with βουλευ- forms εβουλευ-, which is the tense-stem of the imperfect indicative active; the σ, the tense-characteristic of the first aorist, and thus the stem of this part will be εβουλευσ-; the α is the connecting vowel of the indicative, inserted for ease of pronunciation; and the το is the person-ending of the third person singular of an historic tense of the middle voice. So we "parse" ἐβουλεύσα-το as the third person, singular number, first aorist, middle voice, from βουλεύομαι; the active form of which is βουλεύω, and the chief parts are βουλεύω, βουλεύσω, βεβούλευ-κα; for in all instances the root must be given as found in the lexicons, and the principal parts, as well as (1) the person, (2) the number, (3) the mood, (4) the tense, (5) the voice, of every verb and every form of every verb that is met with.

The participles in the paradigm are—present, λύων; future, λύσων; second aorist, λιπών; first aorist, λύσας; first perfect, λελυκώς; second perfect, πεφηνώς. Of these, λύων, λύσων, and λιπών are declined like ὤν, which occurs in lesson XI., and πεφηνώς is declined like λελυκώς. The forms of λύσας and λελυκώς will serve as a pattern for the rest.

DECLENSION OF THE PARTICIPLE λύσας, λύσᾶσα, λῦσαν, *about loosing.*

Singular.

	MASC.	FEM.	NEUT.
Nom.	λύ-σας	λύ-σᾶσα	λῦ-σαν.
Gen.	λύ-σαντος	λυ-σάσης	λύ-σαντος.
Dat.	λύ-σαντι	λυ-σάσῃ	λύ-σαντι.
Acc.	λύ-σαντα	λύ-σᾶσαν	λῦ-σαν.

Dual.

N.A.	λύ-σαντε	λυ-σάσα	λύ-σαντε.
G.D.	λυ-σάντοιν	λυ-σάσαιν	λυ-σάντοιν.

Plural.

Nom.	λύ-σαντες	λύ-σασαι	λύ-σαντα.
Gen.	λυ-σάντων	λυ-σασῶν	λυ-σάντων.
Dat.	λύ-σασι	λυ-σάσαις	λύ-σασι.
Acc.	λύ-σαντας	λυ-σάσας	λύ-σαντα.

THE PARTICIPLE λελυκώς, λελυκυῖα, λελυκός, *having loosed.*

Singular.

	MASC.	FEM.	NEUT.
Nom.	λελυ-κώς	λελυ-κυῖα	λελυ-κός.
Gen.	λελυ-κότος	λελυ-κυίας	λελυ-κότος.
Dat.	λελυ-κότι	λελυ-κυίᾳ	λελυ-κότι.
Acc.	λελυ-κότα	λελυ-κυῖαν	λελυ-κός.

Dual.

N.A.	λελυ-κότε	λελυ-κυία	λελυ-κότε.
G.D.	λελυ-κότοιν	λελυ-κυίαιν	λελυ-κότοιν.

Plural.

Nom.	λελυ-κότες	λελυ-κυῖαι	λελυ-κότα.
Gen.	λελυ-κότων	λελυ-κυιῶν	λελυ-κότων.
Dat.	λελυ-κόσι	λελυ-κυίαις	λελυ-κόσι.
Acc.	λελυ-κότας	λελυ-κυίας	λελυ-κότα.

PARADIGM OF THE REGULAR VERB λύω, *I loose* (MIDDLE VOICE).

INDICATIVE MOOD.

	Present.—Tense-stem λυ-.	*Imperfect.*—Tense-stem ἐ-λυ-.
Sing. 1.	λύ-ομαι, *I loose myself* or *am loosed*, etc.	ἐ-λυ-όμην, *I was loosing myself*, etc.
2.	λύ-ῃ* or λύ-ει.	ἐ-λύ-ου.
3.	λύ-εται.	ἐ-λύ-ετο.
Dual. 1.	λυ-όμεθον.	ἐ-λυ-όμεθον.
2.	λύ-εσθον.*	ἐ-λύ-εσθον.
3.	λύ-εσθον.*	ἐ-λυ-έσθην.
Plur. 1.	λυ-όμεθα.	ἐ-λυ-όμεθα.
2.	λύ-εσθε.*	ἐ-λύ-εσθε.
3.	λύ-ονται.	ἐ-λύ-οντο.

Future.—Tense-stem λυ-σ-.

Sing. 1. λύ-σ-ομαι, *I shall loose myself.*

(The person-endings are like the Present.)

First Aorist.—Tense-stem ἐ-λυ-σ-.

Sing. 1. ἐ-λυ-σ-άμην, *I loosed myself.*
2. ἐ-λύ-σ-ω.
3. ἐ-λύ-σ-ατο.
Dual. 2. ἐ-λύ-σ-ασθον.
3. ἐ-λυ-σ-άσθην.
Plur. 1. ἐ-λυ-σ-άμεθα.
2. ἐ-λύ-σ-ασθε.
3. ἐ-λύ-σ-αντο.

Second Aorist.—Tense-stem ἐ-λιπ-.

Sing. 1. ἐ-λιπ-όμην, *I remained behind.*

(Like the Imperfect Indicative.)

SUBJUNCTIVE MOOD.

Present.—Tense-stem λυ-.

Sing. 1. λύ-ωμαι, *I may loose myself,* [etc.
2. λύ-ῃ.*
3. λύ-ηται.
Dual. 2. λύ-ησθον.
3. λύ-ησθον.
Plur. 1. λυ-ώμεθα.
2. λύ-ησθε.
3. λύ-ωνται.

First Aorist.—Tense-stem λυ-σ-.

Sing. 1. λύ-σ-ωμαι, *I may loose myself*, etc.
2. λύ-σ-ῃ.* (Like the Subjunctive Present.)

Second Aorist.—Tense-stem λιπ-.

Sing. 1. λίπ-ωμαι, *I may remain behind*

(Like the Subjunctive Present.)

OPTATIVE MOOD.

	Imperfect.—Tense-stem λυ-.	*First Aorist.*—Tense-stem λυ-σ-.
Sing. 1.	λυ-οίμην, *I might loose myself*, etc.	λυ-σ-αίμην, *I might loose myself*, etc.
2.	λύ-οιο.	λύ-σ-αιο.
3.	λύ-οιτο.	λύ-σ-αιτο.
Dual. 2.	λύ-οισθον.	λύ-σ-αισθον.
3.	λυ-οίσθην.	λυ-σ-αίσθην.
Plur. 1.	λυ-οίμεθα.	λυ-σ-αίμεθα.
2.	λύ-οισθε.	λύ-σ-αισθε.
3.	λύ-οιντο.	λύ-σ-αιντο.

Future.—Tense-stem λυ-σ-.

Sing. 1. λυ-σ-οίμην, *I would loose myself*, etc.

(The person-endings like the Optative Imperfect.)

Second Aorist.—Tense-stem λιπ-.

Sing. 1. λίπ-οιμην, *I might* or *would remain behind*, etc.

(Like the Optative Imperfect.)

IMPERATIVE MOOD.

	Present.—Tense-stem λυ-.	*First Aorist.*—Tense-stem λυ-σ-.
Sing. 2.	λύ-ου, *loose thou thyself*, etc.	λῦ-σ-αι,* *loose thyself*, etc.
3.	λυ-έσθω.	λυ-σ-άσθω.
Dual. 2.	λύ-εσθον.*	λύ-σ-ασθον.
3.	λυ-έσθων.*	λυ-σ-άσθων.*
Plur. 2.	λύ-εσθε.*	λύ-σ-ασθε.
3.	λυ-έσθωσαν (commonly -έσθων*).	λυ-σ-άσθωσαν (commonly -άσθων*).

Second Aorist.—Tense-stem λιπ-.

Sing. 1. λιπ-οῦ, -έσθω, *remain behind.*

(Like the Present.)

INFINITIVE MOOD.

Present.	λύ-εσ-θαι, *to loose oneself*, or *to be loosed.*
First Aorist.	λύ-σ-ασ-θαι, *to have loosed oneself.*
Second Aorist.	λιπ-έσθαι, *to have remained behind.*

PARTICIPLES.

Present.	λυ-όμενος, *loosing oneself.*
First Aorist.	λυ-σ-άμενος, *having loosed.*
Second Aorist.	λιπ-όμενος, *having remained behind.*

EXERCISE 68.

Translate into English :—

1. **Λυοίμην.** 2. **Λυσοίμην.** 3. **Λύομαι.** 4. **Λυώμαι.** 5. **Ἐλυόμην.** 6. **Ἐλυσάμην.** 7. **Λύσομαι.** 8. **Ἐλιπόμην.** 9. **Λύονται.** 10. **Ἐλύοντο.** 11. **Ἐλύσαντο.** 12. **Λύσαισθε.** 13. **Λιποίμην.** 14. **Λιπέσθαι.** 15. **Λιπόμενος.** 16. **Λύσασθαι.** 17. **Λύεσθαι.** 18. **Λυόμενος.** 19. **Λύσασθε.** 20. **Λίπωμαι.** 21. **Ἐλύσω.** 22. **Λύσηται.** 23. **Λυέσθων.** 24. **Λύοισθον.** 25. **Λυομένου.** 26. **Ἐλύεσθε.** 27. **Λυσάμενοι.** 28. **Λύοιντο.** 29. **Λυσαίμεθα.**

EXERCISE 69.

Translate into Greek :—

1. I might loose myself. 2. He might loose himself. 3. They might loose themselves. 4. To loose

oneself. 5. Loosing oneself. 6. Loose yourselves. 7. He would loose himself. 8. Let him loose himself. 9. We may loose ourselves. 10. They will loose themselves. 11. He may loose himself. 12. You two might have loosed yourselves. 13. You may loose yourselves. 14. You were left behind. 15. He may have remained behind. 16. Do ye remain behind. 17. To have loosed oneself.

Conjugate, according to the active and middle paradigms, these verbs:—**παιδεύω**, *I instruct, educate*; **βασιλεύω**, *I reign*. The chief parts are—**παιδεύω, παιδεύσω, πεπαίδευκα, πεπαίδευμαι**; and **βασιλεύω, βασιλεύσω, βεβασίλευκα, βεβασίλευμαι**.

THE PASSIVE VOICE OF λύω.

(The Present and Imperfect are the same as in the Middle Voice.)

INDICATIVE MOOD.

First Aorist.—Tense-stem **ε-λυ-θ-**.

Sing. 1. **ἐ-λύ-θην**, *I was loosed*, etc.
2. **ἐ-λύ-θης.**
3. **ἐ-λύ-θη.**
Dual. 2. **ἐ-λύ-θητον.**
3. **ἐ-λυ-θή-την.**
Plur. 1. **ἐ-λύ-θημεν.**
2. **ἐ-λύ-θητε.**
3. **ἐ-λύ-θησαν.**

First Future.—Tense-stem **λυ-θη-σ-**.

Sing. 1. **λυ-θή-σ-ομαι**, *I shall be loosed*, etc.

(Like the Indicative Present Middle.)

Second Aorist.—Tense-stem **ε-τριβ-**.

Sing. 1. **ἐ-τρίβ-ην**, *I was rubbed*, etc.

(Like the Indicative First Aorist Passive.)

Second Future.—Tense-stem **τριβ-η-σ-**.

Sing. 1. **τριβ-ή-σ-ομαι**, *I shall be rubbed.*

(Like the Indicative First Future Passive.)

	Perfect.—Tense-stem **λε-λυ-**.	*Pluperfect.*—Tense-stem **ε-λε-λυ-**.
Sing. 1.	**λέ-λυ-μαι**, *I have been loosed*, etc.	**ἐ-λε-λύ-μην**, *I had been loosed*, etc.
2.	**λέ-λυ-σαι.**	**ἐ-λέ-λυ-σο.**
3.	**λέ-λυ-ται.**	**ἐ-λέ-λυ-το.**
Dual. 2.	**λέ-λυ-σθον.***	**ἐ-λέ-λυ-σθον.**
3.	**λέ-λυ-σθον.***	**ἐ-λε-λύ-σθην.**
Plur 1.	**λε-λύ-μεθα.**	**ἐ-λε-λύ-μεθα.**
2.	**λέ-λυ-σθε.***	**ἐ-λέ-λυ-σθε.**
3.	**λέ-λυ-νται.**	**ἐ-λέ-λυ-ντο.**

Note that when the tense-ending **-μαι** of the perfect passive is preceded by a consonant, the third person plural is supplied, for euphony's sake, by the perfect participle with **εἰσί** (for **τέτυπνται, τετυμμένοι εἰσί**), and in the pluperfect, **τετυμμένοι ἦσαν**.

Perfect Future, or *Third Future.*—Tense-stem **λε-λυ-σ-**.

Sing. 1. **λε-λύ-σ-ομαι**, ***I shall have been loosed.***

(Like the Indicative Present.)

SUBJUNCTIVE MOOD.

	First Aorist.—Tense-stem **λυ-θ-**.	*Perfect.*—Tense-stem **λε-λυ-**.
Sing. 1.	**λυ-θ-ῶ**, *I may be loosed*, etc.	**λε-λυ-μένος ὦ**, ***I may have been loosed*, etc.**
2.	**λυ-θ-ῇς.**	**λε-λυ-μένος ᾖς.**
3.	**λυ-θ-ῇ.**	**λε-λυ-μένος ᾖ.**
Dual. 2.	**λυ-θ-ῆτον.**	**λε-λυ-μένω ἦτον.**
3.	**λυ-θ-ῆτον.**	**λε-λυ-μένω ἦτον.**
Plur. 1.	**λυ-θ-ῶμεν.**	**λε-λυ-μένοι ὦμεν.**
2.	**λυ-θ-ῆτε.**	**λε-λυ-μένοι ἦτε.**
3.	**λυ-θ-ῶσι.**	**λε-λυ-μένοι ὦσι.**

Second Aorist.—Tense-stem **τριβ-**.

Sing. 1. **τριβ-ῶ**, *I may be rubbed.*

(Like the Subjunctive First Aorist Passive.)

OPTATIVE MOOD.

	First Aorist.—Tense-stem **λυ-θ-**.	*Perfect.*—Tense-stem **λε-λυ-**.
Sing. 1.	**λυ-θ-είην**, *I might be loosed*, etc.	**λε-λυ-μένος εἴην**, ***I might have been loosed*, etc.**
2.	**λυ-θ-είης.**	**λε-λυ-μένος εἴης.**
3.	**λυ-θ-είη.**	**λε-λυ-μένος εἴη.**
Dual. 2.	**λυ-θ-(είητον) -εῖτον.**	**λε-λυ-μένω εἶτον.**
3.	**λυ-θ-(ειήτην) -είτην.**	**λε-λυ-μένω εἴτην.**
Plur. 1.	**λυ-θ-(είημεν) -εῖμεν.**	**λε-λύ-μενοι εἶμεν.**
2.	**λυ-θ-(είητε) -εῖτε.**	**λε-λύ-μενοι εἶτε.**
3.	**λυ-θ-(είησαν) -εῖεν.**	**λε-λύ-μενοι εἶεν.**

First Future.—Tense-stem **λυ-θη-σ-**.

Sing. 1. **λυ-θη-σ-οίμην**, *I would be loosed.*

(Like the Optative Imperfect Middle.)

Second Aorist.—Tense-stem **τριβ-**.

Sing. 1. **τριβ-είην**, *I might be rubbed.*

(Like the Optative First Aorist Passive.)

Second Future.—Tense-stem **τριβ-η-σ-**.

Sing. 1. **τριβ-η-σ-οίμην**, *I would be rubbed.*

(Like the Optative First Future Passive.)

Perfect Future, or *Third Future.*—Tense-stem **λε-λυ-σ-**.

Sing. 1. **λε-λυ-σ-οίμην**, ***I would have been loosed.***

(Like the Optative Imperfect.)

IMPERATIVE MOOD.

	First Aorist.—Tense-stem λυ-θ-.	*Perfect.*—Tense-stem λε-λυ-.
Sing. 2.	λύ-θ-ητι, *be thou loosed*, etc.	λέ-λυ-σο.
3.	λυ-θ-ήτω.	λε-λύ-σθω.
Dual. 2.	λύ-θ-ητον.	λέ-λυ-σθον.*
3.	λυ-θ-ήτων.	λε-λύ-σθων.*
Plur. 2.	λύ-θ-ητε.	λέ-λυ-σθε.*
3.	λυ-θ-(ήτωσαν) -έν-των.	λε-λύ-σθωσαν (commonly -σθων *).

Second Aorist.—Tense-stem τριβ-η-.

Sing. 2. τρίβ-η-θι, *be thou rubbed.*
3. τριβ-ήτω.

(Like the Imperative First Aorist Passive.)

INFINITIVE MOOD.

First Aorist.	λυ-θ-ῆναι, *to have been loosed.*
First Future.	λυ-θή-σ-εσθαι, *to be about to be loosed.*
Second Aorist.	τριβ-ῆναι, *to have been rubbed.*
Second Future.	τριβ-ή-σεσθαι, *to be about to be rubbed.*
Perfect.	λέ-λυ-σθαι, *to have been loosed.*
Perfect Future, or Third Future.	λε-λύ-σ-εσθαι, *to be about to be loosed.*

PARTICIPLES.

First Aorist.	λυ-θ-είς, *having been loosed*
First Future.	λυ-θη-σ-όμενος, *being about to be loosed.*
Second Aorist.	τριβ-είς, *having been rubbed.*
Second Future.	τριβ-η-σ-όμενος, *being about to be rubbed.*
Perfect.	λε-λυ-μένος, *having been loosed.*
Perfect Future, or Third Future.	λε-λυ-σ-όμενος, *being about to be loosed.*

VERBAL ADJECTIVES.

λυτός, *loosed.* λυτέος, *one who ought to be loosed.*

EXERCISE 70.

Translate into English :—

1. Ἐτρίβη. 2. Τριβῇ. 3. Τριβείης. 4. Τριβείη. 5. Λυθείτην. 6. Λυθεῖεν. 7. Λυθήτω. 8 Λυθῆναι. 9. Λυθησόμενος. 10. Τριβῆναι. 11. Τριβησόμενος. 12. Ἐλύθης. 13. Ἐλύθητε. 14. Λυθήσῃ. 15. Λύθωμεν. 16. Λυθεῖμεν. 17. Λυθῶσι. 18. Λυθείς. 19. Λυθήσεσθαι. 20. Τριβείς. 21. Τριφθήτω. 22. Λέλυμαι. 23. Ἐλελύμην. 24. Λελύσομαι. 25. Λέλυνται. 26. Ἐλέλυντο. 27. Λελυμένος εἴης.

EXERCISE 71.

Translate into Greek :—

1. He was loosed. 2. He may have been loosed. 3. He might have been loosed. 4. He shall be rubbed. 5. They shall be loosed. 6. He was rubbed. 7. I have been loosed. 8. Thou mayest have been loosed. 9. They shall have been loosed.

Of the participles in the middle and passive voice, those which end in -ος (-μενος) are declined like ἀγαθός, -ή, -ον. Of those which end in -εις, take the following as a model :—

DECLENSION OF λυθείς, λυθεῖσα, λυθέν, *loosed.*

Singular.

	MASC.	FEM.	NEUT.
Nom.	λυθείς	λυθεῖσα	λυθέν.
Gen.	λυθέντος	λυθείσης	λυθέντος.
Dat.	λυθέντι	λυθείσῃ	λυθέντι.
Acc.	λυθέντα	λυθεῖσαν	λυθέν.

Dual.

	MASC.	FEM.	NEUT.
N.A.	λυθέντε	λυθεῖσα	λυθέντε.
G.D.	λυθέντοιν	λυθείσαιν	λυθέντοιν.

Plural.

	MASC.	FEM.	NEUT.
Nom.	λυθέντες	λυθεῖσαι	λυθέντα.
Gen.	λυθέντων	λυθεισῶν	λυθέντων.
Dat.	λυθεῖσι	λυθείσαις	λυθεῖσι.
Acc.	λυθέντας	λυθείσας	λυθέντα.

PERSONAL TERMINATIONS OF THE MIDDLE VOICE.

	PRINCIPAL TENSES.			HISTORICAL TENSES.		
	1st Pers.	*2nd Pers.*	*3rd Pers.*	*1st Pers.*	*2nd Pers.*	*3rd Pers.*
Sing.	-μαι.	-σαι.	-ται.	-μην.	-σο.	-το.
Dual.		-σθον.	-σθον.		-σθον.	-σθην.
Plur.	-μεθα.	-σθε.	-νται.	-μεθα.	-σθε.	-ντο.

The student will find an advantage in comparing together the three voices. The relation of their leading parts may be seen in the following

CONSPECTUS OF THE THREE VOICES.

INDICATIVE MOOD, FIRST PERSON SINGULAR.

	Active Voice.	*Middle Voice.*	*Passive Voice.*
Present.	λύ-ω.	λύ-ο-μαι.	
Imperf.	ἔ-λυ-ον.	ἐ-λυ-όμην.	
Future.	λύ-σ-ω.	λύ-σομαι.	λυ-θή-σ-ομαι.
1 Aorist.	ἔ-λυ-σ-α.	ἐ-λυ-σάμην.	ἐ-λύ-θην.
1 Perf.	λέ-λυ-κ-α.		λέ-λυ-μαι.
1 Plup.	ἐ-λε-λύ-κ-η.		ἐ-λε-λύ-μην.
2 Perf.	πέ-φην-α.	P.F. λε-λύ-σ-ομαι.	
2 Plup.	ἐ-πε-φήν-ειν.		
2 Aorist.	ἔ-λιπ-ον.	ἐ-λιπ-όμην.	ἐ-τρί-βην.
2 Fut.			τριβ-ή-σ-ομαι.

GENERAL CONSPECTUS OF THE GREEK VERB.

ACTIVE VOICE.

	Indic.	*Subj.*	*Optative.*	*Imper.*	*Infin.*	*Part.*
Pres.	λύω.	λύω.	λύοιμι.	λῦε.	λύειν.	λύων.
Imp.	ἔλυον,					

	Indic.	*Subj.*	*Optative.*	*Imper.*	*Infin.*	*Part.*
Fut.	λύσω.		λύσοιμι.		λύσειν.	λύσων.
1 Aor.	ἔλυσα.	λύσω.	λύσαιμι.	λῦσον.	λῦσαι.	λύσας.
1 Perf.	λέλυκα.	λελύκω.	λελύκοιμι.	λέλυκε.	λελυκέναι.	λελυκώς.
1 Plup.	ἐλελύκη.					
2 Perf.	πέφηνα.	πεφήνω.	πεφήνοιμι.	πέφηνε.	πεφηνέναι.	πεφηνώς.
2 Plup.	ἐπεφήνειν.					
2 Aor.	ἔλιπον.	λίπω.	λίποιμι.	λιπε.	λιπεῖν.	λιπών.
			MIDDLE VOICE.			
Pres.	λύομαι.	λύωμαι.	λυοίμην.	λύου.	λύεσθαι.	λυόμενος.
Imp.	ἐλυόμην.					
Fut.	λύσομαι.		λυσοιμην.		λύσεσθαι.	λυσόμενος
1 Aor.	ἐλυσάμην.	λύσωμαι.	λυσαιμην.	λῦσαι.	λυσασθαι.	λυσάμενος.
2 Aor.	ἐλιπόμην.	λίπωμαι.	λιποιμην.	λιποῦ.	λιπέσθαι.	λιπόμενος.
			PASSIVE VOICE.			
1 Aor.	ἐλύθην.	λυθῶ.	λυθειην.	λύθητι.	λυθῆναι.	λυθείς.
1 Fut.	λυθήσομαι.		λυθησοίμην.		λυθησεσθαι	λυθησόμενος.
Perf.	λέλυμαι.	λελυμενος ὦ.	λελυμένος εἴην.	λέλυσο.	λελῦσθαι.	λελυμένος.
Plup.	ἐλελύμην.					
P. Fut.	λελύσομαι.		λελυσοίμην.		λελύσεσθαι.	λελυσόμενος.
2 Aor.	ἐτρίβην.	τριβῶ.	τριβειην.	τρίβηθι.	τριβῆναι.	τριβείς.
2 Fut.	τριβήσομαι.		τριβησοίμην.		τριβήσεσθαι.	τριβησόμενος.

We remarked before on page 258 of Volume VI. on the close connection in sense between the passive and middle. Thus we find the present and imperfect the same in both; and, in the same way, the perfect and pluperfect passive, as well as the future perfect, often bear a middle signification.

A glance at the general conspectus will show that this large array of separate tenses is not complete in all its parts. The right to appear in the conspectus may be disputed in the instance of the perfect subjunctive and optative of the passive voice, inasmuch as they have no separate and independent forms, but are each made up of a participle and a part of the verb *εἶναι*.

The student should form for himself, solely by the aid of memory. a general conspectus of the Greek verb, in imitation of the one just given, taking as his verb—

πιστεύω (*I believe*), *πιστεύσω*, *πεπίστευκα*, *πεπίστευμαι*.

ETYMOLOGICAL VOCABULARY.

Λύω, *I loose*, unbind.

Λύσις, *a loosing*.

Λυσί-θριξ, *-τριχος*, *having the hair loose* (*θρίξ*, *τριχός*, *ἡ*, *hair*).

Λυσίμαχος, *putting an end to the fight* (*μάχη*, *-ης*, *ἡ*, *battle*).

Λύσιμος, loosing.

Λυσίνομος, breaking the law (*νόμος*, *-ου*, *ὁ*, *law*).

Λυτήριος, *loosing*, redeeming, healing.

Λύτρον, *loosing-money*, a ransom.

Λυτρόω, I buy off, *ransom*.

Λύτρωσις, *-εως*, *ἡ*, *a ransom*.

Λυτρωτής, *-οῦ*, *ὁ*, a ransomer, *a redeemer*.

Ἀπο-λύω, *I buy off*.

Δια-λύω, *I separate*.

Κατα-λύω, *I dissolve*, break.

Παρα-λύω, I remove, destroy; hence our word *paralysis*.

Each of these various compounds of λύω—namely, ἀπολύω, παραλύω, etc.—has its own set of derivatives. The student, then, in making himself thoroughly acquainted with λύω, has taken steps towards the acquirement of an immense number of Greek words.

THE PRESENT, IMPERFECT, FUTURE, AND FIRST AORIST TENSES, ACTIVE VOICE.

A few remarks on some of the forms of the verb of which a full paradigm has been given may be of service to the student of these lessons.

In the conjugation *-ω*, the person-endings in the course of time underwent changes, as may be learnt from the older conjugation, namely, that in *-μι*, as well as from the dialects, or forms of the language in use among the Dorians, the Æolians, etc.—forms more ancient than the Attic, which is considered the standard for ordinary prose. In the first person singular indicative and subjunctive of the active voice *-μι* has been dropped, and *-τι* in the third person singular; thus the forms originally were *λύομι* or *λύωμι* instead of *λύω*, and *λύετι* instead of *λύει*. So (*ν* being the first person suffix in historic tenses) the first singular indicative of the first aorist was originally *ἔλυσ-ν*, instead of, as now, *ἔλυσα*. (For final *ν* after a consonant becoming *ἀ* *vide supra* lesson IV.) In the second person of the imperative active, *-θι* was dropped, so that we have *λῦε* instead of *λύεθι*.

The second person singular active has the termination *-σθα* in the following forms:—*οἶσθα* (in Latin, *nosti*), *thou knowest*, from the perfect *οἶδα*, used with a present signification, as *I know*; *ᾔδεισθα* and *ᾔδησθα*, the pluperfect to *οἶδα*, used with an imperfect meaning, as, *thou knewest*; *ἔφησθα*, *thou saidst*, imperfect from *φημί*, *I*
ἦσθα, *thou wast*, imperfect from *εἰμί*, *I am*;
thou wentest, imperfect from *εἶμι*, *I go*.

The original form of the first person indicative was *-μες* instead of *-μεν*, resembling the Latin termination *-mus*. Thus the Dorians said *τύπτομες*, *we strike*, instead of *τύπτομεν*; so in the Latin, percuti*mus*; so also *γράφ-ο-μες*, *we write* (in Latin *scrib-i-mus*).

The original form of the third person plural of the principal tenses, active voice, ended in *-ντι*; the *τ* passed into *σ*, and the *ν* was dropped, and so *βουλεύοντι* became first *βουλεύονσι*, and then *βουλεύουσι*, *they advise*.

The Æolic *-ειας, -ειε(ν), -ειαν*, instead of *-αις, -αι, -αιεν*, of the optative first aorist active, is more usual than the first form given in the paradigm.

In the second person singular indicative present and future, middle or passive, the Attics, in addition to the form in *-ῃ*, have another form in *-ει*, as *λύῃ* and *λύει*, *λύσῃ* and *λύσει*, *λελύσῃ* and *λελύσει*, *λυθήσῃ* and *λυθήσει*, *τριβήσῃ* and *τριβήσει*. This form in *-ει* is exclusively used in the three following verbs, namely:—

βούλομαι, I will; *βούλει, thou willest* (subj. *βούλῃ*).
οἴομαι, I think; *οἴει, thou thinkest* (subj. *οἴῃ*).
ὄψομαι, I shall see; *ὄψει, thou shalt see* (subj. *ὄψῃ*).

When in the future of the active and middle *-σω, -σομαι*, in roots of two or more syllables, a short vowel *ᾰ, ε, ῐ* precedes the *σ*, the *σ* in many verbs is dropped, and a new form is produced, ending in *-ῶ, -οῦμαι* (mark the circumflex); thus, *ἐλάω* (commonly *ἐλαύνω*), *I drive*, *ἐλάσω, ἐλῶ*; and so on in the other persons—*ἐλᾷς, ἐλᾷ, ἐλῶμεν, ἐλᾶτε, ἐλῶσι*. This abbreviated form bears the designation of *the Attic future*, because employed by Attic writers. Some other examples of it are:—

Τελέω, *I end.*	*τελέ-σ-ω*, *Attic* *τελῶ, -εῖς, -εῖ, -οῦμεν, -εῖτε, -οῦσι; τελέ-σ-ομαι, τελοῦμαι, -ῇ, -εῖται*, etc.
Κομίζω, *I carry.*	*κομίσω*, *Attic* *κομιῶ, -ιεῖς, -ιεῖ, -ιοῦμεν, -ιεῖτε, -ιοῦσι; κομιοῦμαι, -ιεῖ, -ιεῖται, -ιούμεθα*, etc.
Βιβάζω, *I step, stride.*	*βιβάσω, βιβάω, βιβῶ, βιβῶμεν*, etc.

These contracted futures are found only in the indicative, the infinitive, and the participle; thus, *τελῶ, τελεῖν, τελῶν*. The verbs which take this form are—(1) *ἐλάω* (*ἐλαύνω*), *τελέω*, and *καλέω* (*I call*); (2) All verbs in *-ίζω*; (3) A few in *-άζω*; (4) Of the verbs in *-μι*, all that end in *-άννυμι*, together with *ἀμφιέννυμι*, *I put on* (clothes), *ἀμφιῶ*.

The student should now have no difficulty in generally forming parts of the verb required in the exercises that ensue. It may, however, be as well to enter a little into detail with the tenses.

KEY TO EXERCISES.

Ex. 66.—1. Loosing. 2. To be about to loose. 3 He is loosing. 4. I have loosed. 5. I had loosed 6. I shall loose. 7. Ye two would loose. 8. Thou wouldest loose. 9. Let him loose. 10. Loose ye. 11. I was loosing. 12. He shall loose. 13. We are loosing. 14. They two were loosing. 15. I might loose. 16. I loosed. 17. He has loosed. 18. He loosed. 19. I might loose. 20. Loose thou. 21. Let those two loose (aor.). 22. Having loosed. 23. I may have loosed. 24. Thou hast loosed. 25. They had loosed. 26. They loosed. 27. They have loosed. 28. Ye might loose. 29. Thou mayest loose. 30. Thou hast appeared. 31. Thou didst leave. 32. Thou mayest have left. 33. Thou mightest leave. 34. Let him leave. 35. Having left. 36. To have appeared. 37. Thou hadst appeared. 38. He might have appeared. 39. He might loose. 40. They might loose.

(*N.B.*—It must be remembered that the meanings given here to the subjunctives and optatives only apply to their use in subordinate sentences.)

Ex. 67.—1. Πέφηνα. 2. Ἐλιπέτην. 3. Λείποι. 4. Λείποιτε. 5. Λύουσι. 6. Λύωσι. 7. Λύοιεν. 8. Λύσαιτε. 9. Λῦε. 10. Λυόντων. 11. Λέλυκα. 12. Λύσετε. 13. Λύσωσι. 14. Λύσειε. 15. Λύειν. 16. Λύσειν. 17. Λύσων. 18. Λύσας 19. Λύῃ. 20. Ἐλελυκέτην. 21. Λυοίτην. 22. Λύητον. 23. Πεφήνασι. 24. Πεφήνατον. 25. Πέφηνε.

ENGLISH LITERATURE.—VI.

[*Continued from Vol. VI., p. 330.*]

THE ELIZABETHAN PERIOD—POETRY.

WHAT we said will have enabled the student to understand some of the influences which had been long at work, and which conduced to bring about the Elizabethan literature; but it must not, of course, be supposed that anything we have said or shall say is an exhaustive account of the subject. Our object in speaking on such matters is not so much to impart positive instruction, as to suggest a line of thought and inquiry which seems to us of great importance to the useful study of literature. To assign causes for the greater phenomena of history—if, indeed, such a thing be possible at all—is quite beyond our scope. But the connection between literature and history is a thing which can generally be traced without much risk of error, and with great profit. To say why one age is through all Europe an age of life, energy, and power, and another age an age of lethargy and monotonous feebleness, we do not attempt. But to fail in observing that the literature of each of these periods partakes of the character of the period would be a serious omission. The sixteenth century was a century of unequalled energy and power in Europe. In the wide extent of its intellectual movements, the strength of men's convictions, the abundance of great men, the variety of fields in which mental energy made itself felt—in thought and in action, in religion, in politics, in science, in the most serious and permanent undertakings, and in more boyish adventure—this century probably stands quite unrivalled in the history of Europe, and certainly so in that of England. We need scarcely remind our readers that this was the era of the Reformation, of the Spanish wars and the defeat of the Armada, of the colonisation of America, no less than the age of Shakespeare and of Bacon.

The great achievements of the age were, however, among the latest fruits of the intellectual life of the nation. During the actual struggles of the Reformation literary power had been perverted and literature stunted by the all-pervading spirit of theological controversy. The Elizabethan literature does not really begin till the latter half of the reign of Elizabeth, and extends to the close of that of James I. When the Queen began her reign, Spenser was a mere child, and neither Shakespeare nor Bacon was born.

But when the literary harvest did begin, it came with a richness never known in any age or country. The mere number of writers in this period, and the extent of their writings, would by itself distinguish it from all others. The poets who wrote during it are counted by hundreds. And the student who bears in mind the barrenness of the preceding age will appreciate the importance of this fact. But almost more extraordinary than the extent of the Elizabethan literature is its variety. The philosophy of Bacon, the poetry of Spenser, and the drama of Shakespeare are types of literary power as dissimilar to one another as can well be imagined. Nor ought we to fail to observe the universality with which the literary impulse was diffused throughout the people. This literature was not only national in the sense of expressing the most ardent patriotism in the most powerful forms, but in the sense, too, that all classes of the nation contributed to it. Sidney and Raleigh, the courtly cavaliers; Bacon, the diligent lawyer, son of a shrewd and successful statesman; Shakespeare, the tradesman's son from a small country town, represent extremely different classes of the social whole. In short, the student who gives most attention to the Elizabethan literature will most fully feel how it is marked by the same qualities that characterise the whole life of England in that day—unequalled extent and unequalled variety of energy and power.

There is one poem produced at quite the commencement of the reign of Elizabeth which must not be passed by, for while its intrinsic merit is considerable, its interest, as marking a transition period in literature, is still greater. Thomas Sackville, Lord Buckhurst, and afterwards Earl of Dorset (*b.* 1536), was both an eminent statesman and an eminent writer in more than one department of literature. We shall have occasion to speak of him hereafter as a dramatist. At present we have to do with him as the designer and in part the writer of a poem or series of poems of extraordinary popularity in their day, entitled, "The Mirror for Magistrates." Sackville's idea seems to have been to bring together for didactic purposes in a poetical form the stories of the lives of the most illustrious men in the history of England whose career was unfortunate. He himself wrote only the "induction," or introduction to the work, and the story of the Duke of Buckingham, first the associate and afterwards the victim of Richard III. The remainder of the work is by various hands, and, for the most part, of inferior merit. Richard Baldwin, George Ferrers, Thomas Churchyard, Thomas Phaer, a Welsh physician and poet, and a less-known writer, John Higgins, were contributors to it. Sackville's own share of the work shows much vigour of imagination, a singular power of description, with great skill in versification; but his music is all in one key, his thoughts are entirely of the gloomy and the painful. We give a few specimens from his "Induction," upon the same principle which we adopt throughout these lessons—that is, to enable the student, by a chain of extracts, to follow the changes in our language and in the style of English versification. The poet, reflecting upon the tragic fate of great men, meets with the impersonation of Sorrow:—

"Musing on this worldly wealth in thought,
Which comes and goes, more faster than we see
The flickering flame that with the fire is wrought,
My busy mind presented unto me
Such fall of peers as in the realm had bee,
That oft I wisht some would their woes descryve,
To warn the rest whom fortune left alive.

"And strait forth stalking with redoubled pace,
For that I sawe the night drew on so fast,
In blacke all clad there fell before my face
A piteous wight, whom woe had all forewast;
Forth on her eyes the crystal tears outbrast,
And sighing sore, her hands she wrong and folde,
Tore all her hair, that ruth was to beholde.

"Her body small, forwithred, and forspent,
As is the stalk that sommer's drought opprest,
Her wealked face with woefull teares bee sprent,
Her colour pale, and, as it seemed her best,
In woe and plaint reposed her rest;
And as the stone that drops of water wears,
So dented were her chekes with fall of teares.

"Her eyes, swollen with flowing streams aflote,
Were with her lookes throwne up full piteously
Her forceless hands together oft she smote,
With dolefull shrikes, that echoed in the skye;
That, in my doome, was never man did see
A wight but halfe so woe-begone as she."

Sorrow becomes his guide, and leads him to the infernal regions, where he meets with Remorse, Dread, Revenge, Misery, Care, and other characters, each of whom is described with much power, and in lines which often remind us of some of Spenser's allegorical descriptions. The following striking verses are from the description of old age:—

"But who had seen him, sobbing, how he stoode,
Unto himself, and how he would bemone
His youth forepast, as though it wrought him good
To talk of youth, all were his youth foregone,

He would have mused, and mervaylde much whereon
This wretched age should life desire so fayne,
And knowes full well lyfe doth but length his payne.

"Crookebackt he was, toothshaken, and blere eyde,
Went on three feet, and sometyme crept on four,
With old lame bones, that rattled by his syde,
His scalp all pild, and he with eld forlore;
His withred fist still knocking at Death's dore,
Fumbling and driveling as he draws his breath
For brief, the shape and messenger of Death."

At last the Duke of Buckingham appears upon the scene, and tells the story of his woes. The whole framework of the poem underwent much alteration, though it certainly received no improvement from its later authors. The stories of later introduction are by no means confined to English characters, nor are the characters always brought upon the scene with anything like Sackville's skill and power.

Contemporary with Sackville was George Gascoigne (*b. circa* 1536), a poet of a class very characteristic of the times. He was a soldier, a courtier, and a poet—brilliant in all these capacities. The poem by which he is known to posterity is a vigorous satire, in blank verse, upon the manners and vices of his day, quaintly entitled "The Steel Glass."

But as we have already said, the supreme greatness of the Elizabethan literature belongs not to the beginning, but to the later period of the reign of the great Queen; and this latter portion of her reign may, with respect to poetry, be again divided into two portions—the period of poetry other than dramatic, during which Spenser held the throne of literature; and the period of the drama, during which Shakespeare reigned supreme. Of course, we do not say there were not great plays written before Shakespeare, and beautiful poems written during the period of his greatness. But it is clearly true that, even putting aside the greatest names, Spenser and Shakespeare, poetry was earlier in its development than the drama. We are, therefore, following the natural order when we treat of Elizabethan poetry before the Elizabethan drama.

Among the Elizabethan poets Spenser holds by far the first place, and there can be little doubt that the popularity of his works, the finish which he gave to the English language, and the beauty and music of his versification, contributed much to promote the cultivation of poetry, and to form the style of contemporary poets. But it will be more convenient to treat of Spenser and his works in a separate lesson, and to devote what remains of the present to a very brief account of some of the other poets of his day.

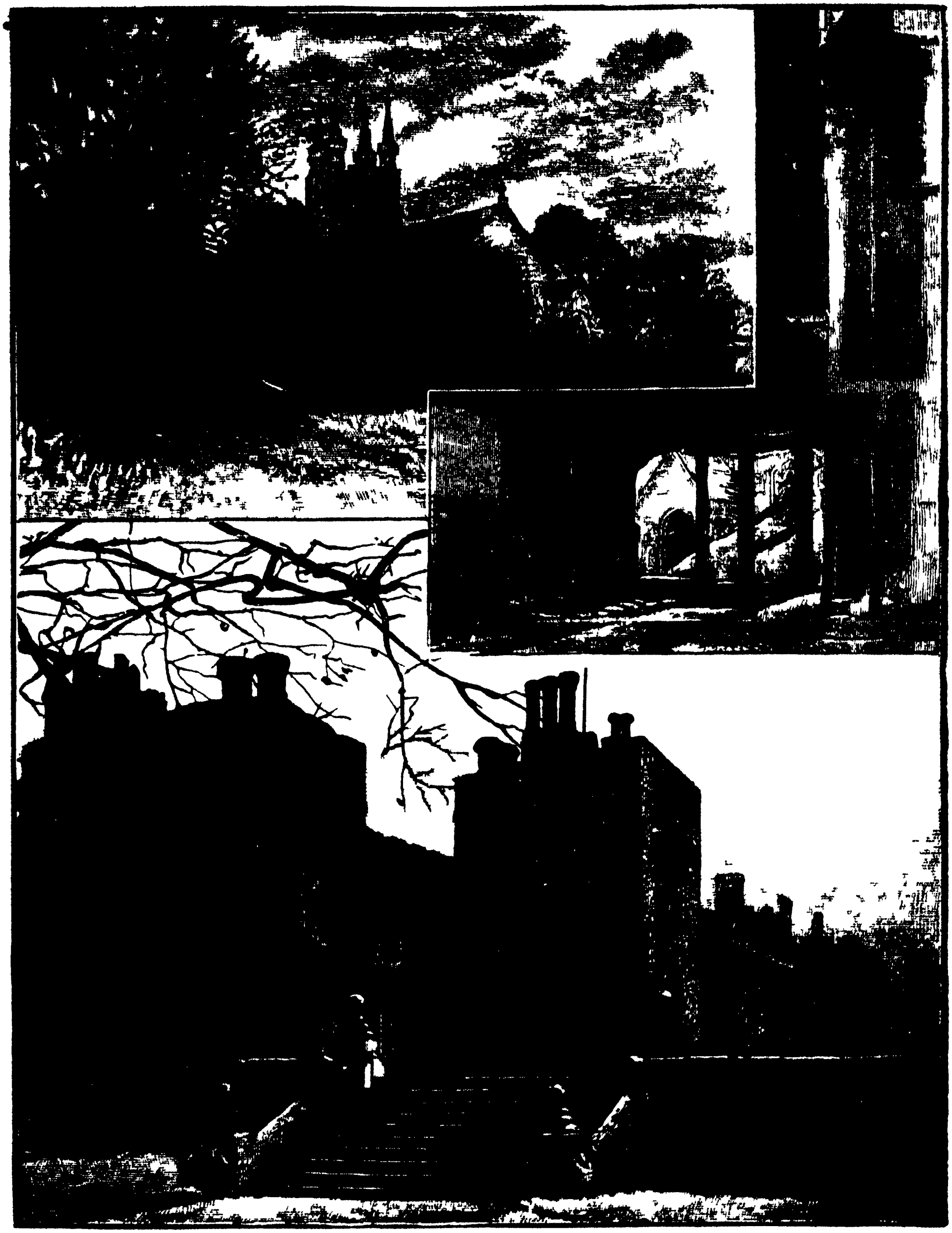
Sir Philip Sidney, born at Penshurst in Kent, whom we shall have to notice hereafter as filling an important place in the history of prose writing in English, and as the generous and discriminating patron of literature, is entitled to a place among the poets of his time, by virtue of his collection of sonnets, "Astrophel and Stella," which are smooth and graceful, but not distinguished by much force or originality.

Samuel Daniel (*b.* 1562) was a poet of great reputation among his contemporaries, though his poems, with all their ease of versification and purity of style, are not very attractive reading in the present day. He wrote many shorter pieces, but his two largest and most important works are a narrative poem, "The History of the Civil Wars," on the contest between the Houses of York and Lancaster; and a dialogue in verse, entitled "Musophilus," which is a sort of defence of literature.

William Warner was by profession an attorney. He was the author of a long poem which he called "Albion's England." This work, like "The Mirror for Magistrates," "The History of the Civil Wars," and many other of the most popular poems of this period, was historical in subject and narrative in form. It purports to be a poetical history of England from the very earliest times to the writer's own day. From its singular terseness and vigour of style, its variety of incident, and the unusual descriptive power which it displays, and perhaps to some extent also from a vein of coarseness quite in harmony with the prevalent taste of the day, Warner's work attained a remarkable popularity.

To somewhat the same class as these belong most of the works of another poet of the same period, Michael Drayton. But Drayton was a poet of greater force, and of far greater variety of power. His chief works are "The Barons' Wars," an historical poem on the civil wars of the days of Edward II.; "England's Heroical Epistles," also historical in subject; and his "Polyolbion." The latter singular work is a sort of itinerary in verse of the whole of England and Wales, in which he goes through every part of the country in turn, and gives his readers all the stories and legends which history or popular imagination has attached to each spot. This work is written in a singular and not very attractive metre, one which tends to weary the ear with the monotony of its cadences. It is in long Alexandrine lines of twelve syllables, rhyming in couplets. We give a very few lines, merely as a specimen of the metre:—

"And near to these our thicks, the wild and frightful herds,
Not hearing other noise but that of chattering birds,
Feed fairly on the lawns; both sorts of seasoned deer,
Here walk the stately red, the speckled fallow there;
The bucks and lusty stags amongst the rascals strewed,
As sometimes gallant spirits amongst the multitude."



PENSHURST

The Church

Gate to the Churchyard

The House, from the Avenue.

To most modern readers the lighter poems of Drayton will be found more attractive than the "Polyolbion." In his "Nymphidia," or the "Court of Fairy," his graceful fancies remind the reader of Ben Jonson's lighter poems.

George Chapman (*b.* 1557 *or* 1559) was known as a dramatist, but his fame with posterity rests upon his great translation of Homer. This translation is written in what we now call ballad metre, that is to say, in alternate lines of eight and six syllables. But in Chapman's day the two lines were written as one long line of fourteen syllables. In its rugged vigour this is probably still the best English translation of Homer.

SIR PHILIP SIDNEY.

Sir John Davies is a type of a class of whom we meet with many in the Elizabethan period—men who combined an active participation in public affairs, or professional business, with a keen devotion to literature. Davies was an eminent lawyer, filled for a long time the office of Attorney-General in Ireland, and was well known as a prudent statesman. In addition to a few shorter poems, he wrote a long argumentative poem on the immortality of the soul, under the title of "Nosce te ipsum." For its clearness and dignity of style, as well as for the skill of its arguments, this work has been much admired. Sir John Davies was also the author of another work on a singularly dissimilar subject, "Orchestra," a poem in honour of dancing.

Phineas and Giles Fletcher were brothers. They were jointly the authors of a curious and in some respects powerful poem, "The Purple Island." The Fletchers belong quite to the close of the Elizabethan period, and in the very title of this poem, as well as in its substance, we find plain evidence that the force and simplicity of the Elizabethan poetry were beginning to give place to the subtlety and quaintness which belonged to the next generation. The Purple Island is the human body, and the poem is a full description of the physical and mental attributes of man.

Joshua Sylvester is a poet whose works are little read now, though they once enjoyed a very general popularity. His principal literary productions were translations of the works of the French poet Du Bartas.

Among the minor poets of the age ought to be mentioned Drummond of Hawthornden, near Edinburgh. He is, perhaps, best known from his intimacy with Ben Jonson; but his sonnets would, had he lived in an age less crowded with poetical genius, have secured him a very distinguished reputation.

Dr. Donne, Dean of St. Paul's, and Joseph Hall, Bishop of Norwich, were the founders of English satire. Bishop Hall was a satirist of considerable power. Donne's satires are familiar to most readers in Pope's modernised version of them.

We have been able to do no more than give a very slight sketch of a few of the most prominent of the Elizabethan poets, other than the dramatists. To attempt more than this would be to turn our lessons into mere catalogues of names. We shall have occasion to show hereafter that many of those who are best known to us as dramatists were also, like Shakespeare himself, poets in other departments as well.

COMMERCIAL CORRESPONDENCE.—I.

FRENCH, GERMAN, AND ENGLISH.

As a pendant to our lessons in French and German, we now bring under the notice of our readers a series of model business letters in English, French, and German, illustrating the various transactions of commercial life.

Under each heading the student will first find a model letter couched in language appropriate to the subject under consideration in English. Immediately after is given, in every case, a close but idiomatic translation of the English model into French and German.

It is unnecessary to do more than point out that anyone who has carefully studied the lessons in French and German which have appeared in the

NEW POPULAR EDUCATOR may soon become an adept in French and German commercial correspondence by means of these model letters of business. We would recommend the learner first to copy the English form without looking at the translations below; then endeavour to translate the English form thus copied out into French and German; and, lastly, to compare his work with the translations given. He should also practise himself in translating each French and German model into English, afterwards correcting his translations by the English forms.

1.—CIRCULAR ON THE RETIREMENT OF A PARTNER IN A FIRM.

Amsterdam, August 16, 1891.

Messrs. Legrand & Co., London.

Gentlemen,—We take the liberty of informing you that our Mr. Jean van Steen will, in conformity with a long-expressed desire, retire from this date from our firm.

Though we regret being deprived of his active co-operation and long experience, the fact of his retirement will not interfere with the conduct of our business.

We are, Gentlemen, your obedient servants,

J. & B. VAN STEEN.

Amsterdam, le 16 *août*, 1891.

Messieurs Legrand & C^{ie}, à Londres.

Messieurs,—Nous prenons la liberté de vous faire part que notre sieur Jean van Steen, désirant quitter les affaires, se retire à dater de ce jour de notre maison.

Sa retraite, quoique nous laissant le vif regret d'être privés de sa coopération active et de son expérience, ne changera rien dans la marche de nos affaires.

Nous avons l'honneur, Messieurs, de vous saluer,

J. & B. VAN STEEN.

Amſterdam, 16 Auguſt, 1891.

Herren Legrand & Co, London.

Wir erlauben uns Ihnen mitzutheilen daß unſer Herr Jean van Steen, einem lange ausgeſprochenen Wunſche folgend, mit dem heutigen Tage aus unſerer Firma ſcheidet. So ſehr wir bedauern, ſeine raſtloſe Thätigkeit und lange Erfahrung in der Folge entbehren zu müſſen, ſo wird ſein Austritt keinerlei Änderung in unſerer Geſchäftsführung hervorrufen.

Hochachtungsvoll,

J. & B. van Steen.

2.—CIRCULAR ANNOUNCING THE ESTABLISHMENT OF A NEW HOUSE OF BUSINESS.

London, August 15, 1891.

Messrs. Petit & Co., Marseilles.

Gentlemen,—We have the honour to inform you that we have this day established a house of business under the firm of

Masters & Johnstone.

We are in hopes that ample capital, our joint experience and acquaintance with business matters, will enable us to give satisfaction to all who may honour us with their confidence.

Begging you to take note of our respective signatures, we refer you to the undermentioned firms,

And have the honour to be, Gentlemen,

Your very obedient servants,

FRED. MASTERS.

ANDREW JOHNSTONE.

Fred. Masters will sign: MASTERS & JOHNSTONE.

Andrew Johnstone will sign: MASTERS & JOHNSTONE.

References permitted to

Messrs. H. Bake, London.
Changarnier, Lyons.
Lilienskin, St. Petersburg.
Mackay, Glasgow.

Londres, le 15 *août*, 1891.

Messieurs Petit & C^{ie}, à Marseille.

Messieurs, — Nous avons l'honneur, de vous prévenir que nous venons d'établir une maison de commerce sous la raison sociale

Masters et Johnstone.

Nous nous flattons que des capitaux suffisants, l'expérience et la connaissance des affaires, nous mettront à même de satisfaire tous ceux qui voudront bien nous honorer de leur confiance.

En vous priant de prendre note de nos signatures respectives, nous nous référons aux maisons ci-dessous, et avons l'honneur d'être, avec une parfaite considération, vos très-humbles serviteurs,

FRED. MASTERS.

ANDREW JOHNSTONE.

Fred. Masters signera: MASTERS & JOHNSTONE.

Andrew Johnstone signera: MASTERS & JOHNSTONE.

Références:

Messieurs H. Bake, Londres.
Changarnier, Lyon.
Lilienskin, St. Pétersbourg.
Mackay, Glasgow.

London, 15 Auguſt, 1891.

Herren Petit & Co., Marſeille.

Wir beehren uns Sie davon zu benachrichtigen, daß wir heute ein Geſchäft unter der Firma

Maſters und Johnſtone

Wir glauben annehmen zu dürfen, daß hinreichendes Capital, Erfahrung, und Bekanntſchaft mit den Geſchäften uns in den Stand ſetzen werden, Alle zu befriedigen, die uns mit ihrem Vertrauen beehren mögen.

Wir erſuchen Sie von unſeren Unterſchriften Kenntniß zu nehmen und indem wir uns auf die unten verzeichneten Firmen beziehen, empfehlen wir uns,

Hochachtungsvollſt,

Fred. Maſters.

Andrew Johnſtone.

Fred. Maſters wird zeichnen: Maſters & Johnſtone.

Andrew Johnſtone wird zeichnen: Maſters & Johnſtone

Referenzen:

Herren H. Bake, London.

Changarnier, Lyon.

Lilienſtin, St. Petersburg.

Mackay, Glasgow.

3.—CIRCULAR NOTIFYING THAT A BUSINESS HAS CHANGED HANDS.

Bremen, August 17, 1891.

Messrs. Roger & Co., Brussels.

Gentlemen,—The natural infirmities incident to old age have constrained me to retire from business, which in future will be conducted by my two sons in their name.

While making known to you this change, I beg you will continue your correspondence with them, and take note of their respective signatures.

I have the honour to remain, Gentlemen,

Your very obedient servant,

FRANZ MEYER.

Mr. Louis Meyer will sign: MEYER BROS.

Karl Meyer will sign: MEYER BROS.

Bremen, le 17 *août*, 1891.

Messieurs Roger & C^ie^, à Bruxelles.

Messieurs,—Les infirmités inséparables de la vieillesse m'engagent à renoncer aux affaires du commerce, que je remets dès ce jour entre les mains de mes deux fils pour qu'ils les dirigent en leur nom.

En vous annonçant ce changement, je vous prie de vouloir bien continuer avec eux votre correspondance, et prendre note de leurs signatures.

Je suis, Messieurs, avec la plus parfaite estime,

Votre très-obéissant serviteur,

FRANZ MEYER.

M. Louis Meyer signera: MEYER FRÈRES.

M. Karl Meyer signera: MEYER FRÈRES.

Bremen, 17 Auguſt, 1891.

Herren Roger & Co., Brüſſel.

Die mit den zunehmenden Jahren erſcheinende Alterschwäche veranlaßt mich, mich von den Geſchäften zurückzuziehen, nachdem ich dieſelben vom heutigen Tage ab in die Hände meiner beiden Söhne gelegt habe.

Indem ich dies zu Ihrer gefl. Kenntniß bringe, bitte ich Sie, Ihre Correſpondenz von jetzt an mit den Genannten zu führen und deren Unterſchriften vorzumerken.

Hochachtungsvoll ergeben,

Franz Meyer.

Herr Louis Meyer wird zeichnen: Gebrüder Meyer.

Herr Karl Meyer wird zeichnen: Gebrüder Meyer.

4.—CIRCULAR ON THE CESSATION OF EXISTENCE OF A FIRM AND WINDING-UP OF AFFAIRS.

Bordeaux, August 18, 1891.

Messrs. Thomas & Co., London.

Gentlemen,—It is with deep regret that I have to inform you of the sad and premature death of my husband, Mons. Martin Auber, only existing partner of the firm of Auber & Co., of this town.

As both my sons are still too young to continue the firm founded by their father, I have but to fulfil the sad duty of thanking my late husband's correspondents for their confidence, and to inform them that the firm Auber & Co. has ceased to exist, and that I intend to superintend the liquidation myself.

Begging you to take note of my signature,

I have the honour to be, Gentlemen,

Your obedient servant,

MARIE AUBER, Widow.

Mme. Auber will sign: AUBER & Co., in liquidation.

Bordeaux, le 18 *août*, 1891.

Messieurs Thomas & C^ie^, à Londres.

Messieurs,—C'est avec la plus vive douleur, que j'ai à vous annoncer la perte douloureuse et prématurée de mon époux, le sieur Martin Auber, seul chef de la maison Auber et C^ie^, de cette ville.

Comme mes deux fils sont encore trop jeunes pour diriger la maison fondée par leur père, il ne me reste que le triste devoir de faire mes remerciements aux correspondants de feu mon mari pour la confiance qu'ils lui ont accordée, et de les prévenir que la maison Auber et C^ie^ n'existe plus, et que je dirigerai la liquidation moi-même.

En vous priant de prendre note de ma signature, et avec l'assurance de ma parfaite considération,

J'ai l'honneur d'être, Messieurs,

Votre humble servante,

MARIE AUBER, Veuve.

Mme. Auber signera: AUBER & C^IE^, en liquidation.

Bordeaux, 18 Auguſt, 1891.

Herren Thomas & Co., London.

Mit tiefer Trauer erfülle ich die ſchmerzliche Pflicht, Sie von dem frühzeitigen Ableben meines Mannes, des Herrn Martin Auber, in Kenntniß zu ſetzen. Derſelbe war alleiniger überlebender Inhaber der Firma Auber & Co. hier.

Da meine beiden Söhne noch zu jung ſind, um die von ihrem Vater gegründete Firma weiterzuführen, bleibt mir nichts übrig, als den Geſchäftsfreunden meines verſtorbenen Mannes für ihr Vertrauen zu danken, und ſie von der Auflöſung der Firma Auber & Co. zu benachrichtigen; ſowie daß ich die Liquidation perſönlich zu überwachen beabſichtige.

Ich erſuche Sie, von meiner Unterſchrift Kenntniß zu nehmen.

Hochachtungsvoll,

Wwe. Marie Auber.

Frau Marie Auber wird zeichnen: Auber & Co., in [Liquidation.

5.—Letter of Inquiry as to Solvency of a Firm.

Havre, August 19, 1891.

Messrs. Lafitte, Paris.

Gentlemen,—We beg to confirm our letter of the 26th of July, and request you to be good enough to let us know your opinion of the solvency of Messrs. Henry Smith Bros., who have referred us to you for the said information.

We shall be obliged if you would also indicate to us the amount of credit we may safely give them.

You may rely upon our discretion.

Merivale Brothers.

Le Havre, le 19 *août*, 1891.

Messieurs Lafitte, à Paris.

Messieurs,—Nous vous confirmons notre lettre du 26 juillet dernier, et vous prions de vouloir bien nous donner des renseignements sur la solvabilité de MM. Henry Smith frères, qui nous ont indiqué votre maison comme pouvant nous les fournir.

Vous nous obligeriez aussi en nous indiquant l'étendue du crédit que vous jugeriez convenable de leur accorder.

Vous pouvez compter sur notre discrétion.

Merivale Frères.

Havre, 19 Auguſt, 1891.

Herren Henry Lafitte & Co., Paris.

Wir beſtätigen unſer Ergebenes vom 26 Juli, und erſuchen Sie uns gütigſt Ihre Anſicht über die Solvenz der Firma Gebrüder Henry Smith mitzutheilen, welche ſich betreffs Informations-Ertheilung auf Sie bezogen hat.

Wir werden Ihnen zu Dank verpflichtet ſein, wenn Sie uns gleichzeitig die Höhe des Credits nennen wollten, welchen wir dieſer Firma ohne Riſico einräumen konnen.

Wir verſichern Sie unſerer Discretion und zeichnen

Hochachtunzsvoll,

Gebrüder Merivale.

6.—Reply to Letter of Inquiry as to Solvency of a Firm.

Paris, August 20, 1891.

Messrs. Merivale Brothers, Havre.

Gentlemen,—We beg to acknowledge the receipt of your letters of the 26th of July and 19th inst.

Although we say that the firm H. Smith Bros. is sound, it is but fair to tell you, in confidence, that their reputation is not entirely above all suspicion; that this suspicion attaches itself chiefly to a want of delicacy and scruple in their business, of which a number of people have from time to time raised complaints, so as to diminish the credit which the firm used to enjoy.

We cannot, however, limit the extent of credit you may be disposed to give them, except in so far as the foregoing may determine you.

Please to send us particulars as to what is being done in quinine in your city, and whether, as with us, it seems to go down. We are offered some of superior quality at 4 francs 50 centimes. Be good enough to send us all the particulars you can obtain of this drug, partly as to the monopoly, as to the news from Peru, especially about the war, and as to the most favourable time for purchase.

We are, Gentlemen,

Your very obedient servants,

Henry Lafitte & Co.

Paris, le 20 *août*, 1891.

Messieurs Merivale Frères, au Havre.

Messieurs,—Nous accusons réception de vos lettres du 26 juillet et du 19 courant.

Tout en vous disant que la maison H. Smith frères est solide, nous devons aussi vous informer confidentiellement qu'elle ne jouit pas entièrement d'une réputation libre de toute censure; que cette censure porte sur un manque de délicatesse et de scrupule dans leurs affaires, dont bon nombre d'individus se plaignent, de manière à diminuer le crédit dont jouissait autrefois cette maison.

Nous ne pourrions donc vous fixer sur l'étendue du crédit à leur accorder sinon par ce que nous venons de dire.

Veuillez bien nous informer comment va le commerce de la quinine sur votre place et nous dire si, comme ici, cet article semble devoir fléchir. On nous en offre, de belle et bonne qualité, à 4fr. 50c. Ayez la bonté de recueillir sur cet article tous les renseignements que vous serez à même de vous procurer, tant sur le monopole, que sur les nouvelles qui arrivent du Pérou, au sujet de la guerre, et sur le moment le plus favorable pour faire des achats.

Agréez, Messieurs, l'assurance de notre parfaite consideration,

Henry Lafitte & C^{ie}.

Paris, 20 Auguſt, 1891.

Herren Gebrüder Merivale, Havre.

Wir bekennen uns zum Empfang Ihrer Geehrten vom 26 Juli und 19 curr.

Obgleich wir die Firma Gebrüder Henry Smith als ſolide kennen, ſo fühlen wir uns doch verpflichtet, Ihnen im Vertrauen mitzutheilen, daß ihr Ruf nicht über allen Verdacht erhaben iſt; daß dieſer Verdacht hauptſächlich einem Mangel an Zartgefühl und an Gewiſſenhaftigkeit in ihrer Geſchäftsführung entſpringt, worüber ſich eine Menge von Kunden von Zeit zu Zeit beſchwert haben; ſo daß der Credit, deſſen dieſe ſich zu erfreuen pflegte, gelitten hat. Wir können Ihnen übrigens nicht die Höhe des Credits angeben, welchen Sie der Firma gewähren dürften, ausgenommen inſoweit das Vorſtehende Sie beſtimmen möchte.

Wir erſuchen Sie, uns gefälligſt zu ſagen, was in Quinin bei Ihnen vorgeht, und ob der Artikel, wie es bei uns der Fall, herunterzugehen ſcheint. Man offerirt uns feine Qualität zu fr 4.50. Senden Sie uns gütigſt alle Informationen welche Sie über dieſen Artikel erhalten können, ſowohl über das Monopol, als auch über die Nachrichten von Peru, ſpeciell über den Krieg, und über den günſtigſten Zeitpunkt zum Einkaufen.

Hochachtungsvoll,
Henry Lafitte & Co.

7.—Letter of Inquiry as to State of Markets under Adverse Circumstances.

Amsterdam, May 2, 1891.

Messrs. J. T. van Praat & Co., London.

Gentlemen,—The latest news from America has overcast the commercial horizon and created a panic in our city. We tremble for the consequences which such a state of things may produce. The best houses are shaking, and we are momentarily expecting a general suspension. We do not know how your markets are, and in any case it would not become us to give you any advice; we merely throw out a hint, that the consequences of these untoward circumstances must be felt with you, as in all the great industrial centres.

Be good enough to give us some information as to what you are doing, what you fear or hope, for we are somewhat uneasy as to the result we are likely to obtain from our stock, which is of considerable importance. In any case we shall not send more, but wait your orders.

In the hope of our hearing from you,
We remain, Gentlemen,
Your obedient servants,
TEN DOREN & J. HAAS.

Amsterdam, le 2 *mai*, 1891.

Messieurs J. T. van Praat & C^{ie}, à Londres.

Les derniers courriers d'Amérique ont obscurci l'horizon commercial et jeté l'épouvante sur notre place. Nous tremblons pour les conséquences que peut amener une situation semblable. Les maisons les plus solides vacillent sur leur base, et l'on s'attend d'un moment à l'autre à une suspension générale. Nous ne savons dans quel état se trouve votre marché et dans tous les cas ce ne serait pas à nous à vous donner des conseils, mais nous pensons que le contre-coup de toutes ces mauvaises affaires doit s'y faire sentir comme dans tous les grands centres industriels.

Veuillez donc être assez bons pour nous donner quelques renseignements sur ce que vous faites, quelles sont vos craintes et vos espérances, car nous sommes peu tranquilles sur les résultats que nous devons retirer de nos marchandises, qui sont d'une certaine importance. En tout cas, nous suspendrons nos envois et attendrons vos commandes.

Dans l'attente de vous lire,
Nous vous présentons,
Messieurs,
Nos salutations cordiales,
TEN DOREN & J. HAAS.

Amſterdam, 2 Mai, 1891.

Herren J. T. van Praat & Co., London.

Die letzten Nachrichten aus Amerika haben den Horizont des Handels getrübt und in unſerer Stadt eine Panik hervorgerufen. Wir zittern vor den Folgen, welche ein ſolcher Zuſtand nach ſich ziehen mag. Die beſten Häuſer wanken, und wir erwarten jeden Augenblick eine allgemeine Einſtellung. Wir wiſſen nicht, wie es ſich mit Ihren Märkten verhält, und es würde uns auf alle Fälle nicht zuſtehen, Ihnen Rath zu ertheilen; wir wollen nur andeuten, daß die Folgen dieſer ungünſtigen Verhältniße ſich ſowohl bei Ihnen als in allen großen induſtriellen Centren fühlbar machen müſſen.

Wir werden Ihnen für gefällige Information über Ihr Vorgehen, Fürchten oder Hoffen verbunden ſein, denn wir ſind einigermaßen für das Reſultat beſorgt, welches wir vorausſichtlich mit unſerem Vorrath von ziemlicher Größe erzielen werden. Wir werden keinenfalls Weiteres ausſenden, ſondern Ihre Aufträge abwarten.

Ihren Nachrichten entgegenſehend zeichnen wir,
Hochachtungsvoll,
Ten Doren & J. Haas.

8.—Letter of Inquiry as to Solvency of a Firm.

Lyons, August 21, 1891.

Messrs. A. J. Peters, London.

Gentlemen,—Upon the recommendation of Messrs. Lambert Bros., of this city, we take the liberty to ask you to be good enough to inform us as to the respectability and solvency of Messrs. A. Wolff & Co., London, Commission Agents and Exporters, who have a house in Paris, Porte St. Martin.

As all their orders are to be sent to the London house, you would oblige us greatly by giving us some information as to the commercial position and repute of the said firm.

Thanking you beforehand for your trouble,
We are, Gentlemen,
Your very obedient servants,
FR. RICHON BROTHERS.

Lyon, le 21 *août*, 1891.

Messieurs A. J. Peters, à Londres.

Sur la recommandation de Messieurs Lambert Frères, de notre ville, nous prenons la liberté de nous adresser à votre obligeance pour avoir des renseignements sur la maison A. Wolff & Cie, de Londres, faisant la Commission et l'Exportation, et ayant un comptoir à Paris, Porte Saint-Martin.

Comme tous leurs achats doivent être expédiés à leur maison de Londres, vous nous obligeriez, Messieurs, en nous adressant quelques renseignements sur leur position commerciale et leur solvabilité.

Nous vous remercions d'avance pour votre obligeance, et vous prions d'agréer,

Messieurs,
Nos salutations empressées,
FR. RICHON FRÈRES.

Lyon, 21 Auguſt, 1891.

Herren A. J. Peters, London.

Geſtützt auf die Empfehlung der Herren Gebrüder Lambert, hier, nehmen wir uns die Freiheit, Sie um gefällige Auskunft über Reſpectabilität und Solvenz von Herren A. Wolff & Co. hier, zu erſuchen. Genannte Firma iſt ein Commiſſions- und Export-Haus, mit einer Filiale in Paris, Porte St. Martin.

Da alle Orders an das Londoner Haus zu ſenden ſind, ſo erſuchen wir Sie um gütige Auskunft über die Verhältniße und den Ruf beſagter Firma.

Genehmigen Sie im Voraus unſeren Dank für Ihre Bemühung.

Hochachtungsvollſt,
Gebrüder Fr. Richon.

ARCHITECTURE.—IV.

[*Continued from Vol. VI., p. 377.*]

THE ROMAN STYLE.

THE early architectural history of Italy is involved in much the same obscurity as that of Greece. It was peopled by various tribes, such as the Etruscans, the Samnites, the Sabines, and others; the most important of whom, and whose works exercised the greatest influence in Roman architecture, being the Etruscans. Rome herself, founded about the middle of the eighth century B.C., in the earlier part of her history was an Etruscan town governed by Etruscan kings and regulated under Etruscan institutions.

Such of the buildings of Etruria as have been preserved possess much of the same character as those of the Pelasgi and of other early settlers in Greece. We find the same Cyclopean masonry in the walls of her towns, and like the Greek settlers they were tomb-builders; they, in their character, however, show a closer affinity to Asiatic sources than we can trace in Greece. In one constructional feature, however, they widely differed. We have already drawn attention to the enormous lintels of stone which covered the Greek gateways and the entrances to their tombs. In Etruria, instead of the lintel they sometimes employed the arch; instead of a series of lintels laid side by side to cover over space, or the superposition of horizontal courses of stone, one overhanging the other till they met at the summit, as in the Tomb of Atreus at Mycenæ, we find the vault; and the arch and the vault are the new constructive features (new in this part of the world, for we have already spoken of examples in Egypt and Assyria) which were destined to effect a revolution in the method of covering over buildings adopted by the Egyptians and the Greeks in their temples. Two methods of covering over space were adopted by the architects of the earlier styles. They are known as the trabeated, from *trabes*, a beam; and the arcuated, from *arcus*, a bow.

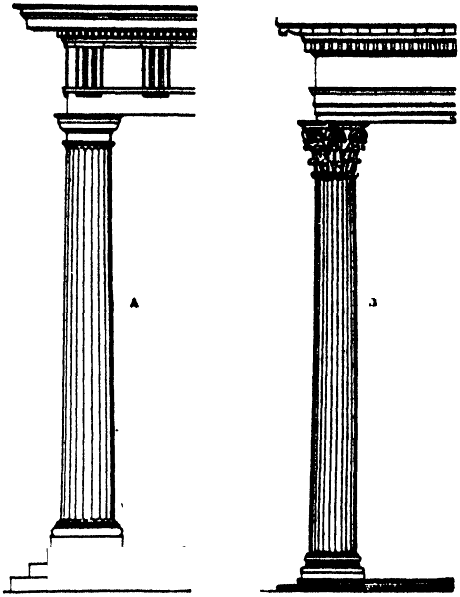


Fig. 10.—A, ROMAN DORIC. B, ROMAN CORINTHIAN.

In trabeated architecture spaces are covered over by beams of wood or stone supported by walls, or on beams carried by columns or piers.

In arcuated architecture the same result is arrived at by throwing arches or vaults over the space to be covered.

The latter is by far the most scientific, but it involves much thicker walls to resist the thrust, and for that reason it is supposed that, although known to the Greeks, it was not employed by them. "An arch never sleeps" is a saying attributed to the Hindoos, by which is meant that in the very essence of its construction the tendency is to sink in the centre and thrust out the haunches. During the process of construction, also, it requires some temporary support, for until it is complete the arch has no strength. In the present day, when we have plenty of timber to make these temporary supports, there is not much difficulty except in arches or vaults of large span, and in such cases the design of the framing or centre employed involves sometimes more calculation and thought than the building of the arch itself.

The Romans therefore, when in course of time they had become the conquerors of the then known world, found themselves in the presence of two distinct principles of construction, viz., that which had already been perfected in the trabeated style of Greece, and that which in a more elementary condition had been practised in her own capital by the Etruscans. The earliest example of the vault is that which forms one of the sewers of Rome, viz., the Cloaca Maxima, built at the beginning of the sixth century B.C., which is vaulted over with three concentric rings of stone. Of Etruscan arch construction there still exist also two gateways at Perugia and an arch at Volterra. Cyclopean walls are found at Palestrina, Cortona, Fiesole, and elsewhere. The only evidence of her domestic architecture is that which is shown in her tombs, for here as in Egypt the last resting-place of the deceased was carved in the solid rock in imitation of the dwelling-house. The examples at Cervetri, Corneto, and other places show us that for their houses they adopted timber roofs, the beams being framed together and rising to the centre, where probably an opening was formed for light. Other tombs, such as the Regulini Galeassi tomb at Cervetri, show a similar system of construction to that employed in the Tomb of Atreus, in horizontal courses of stone overhanging till they nearly meet at the summit, and are then covered over by small slabs of stone.

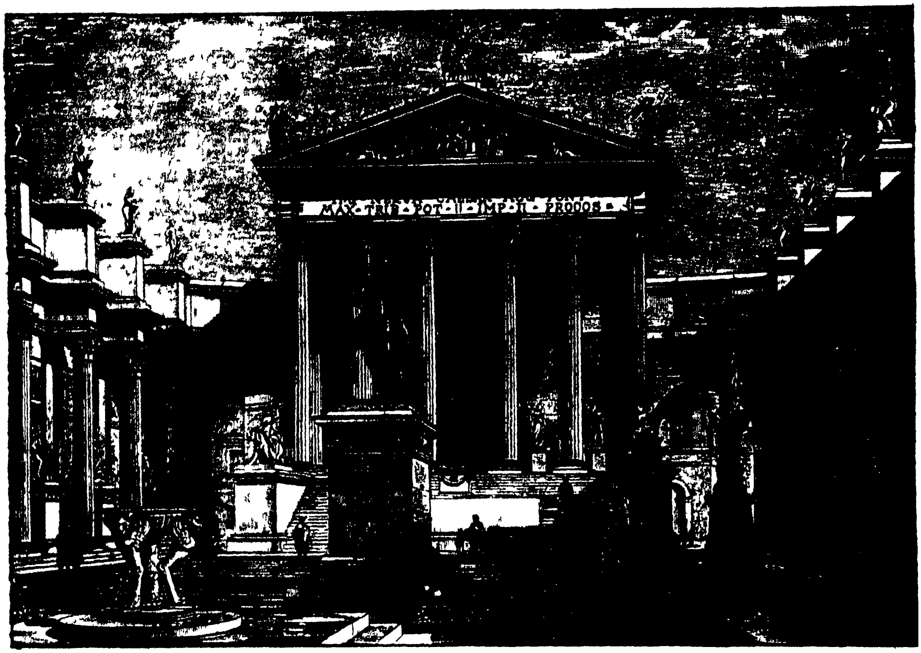


Fig 11 —Temple of Pallas Restoration.

Of the Etruscan temple we have only the descriptions of Vitruvius to go by. There were apparently three cellas or sanctuaries side by side, with a portico of columns in front, carrying timber architraves and superstructures. They had also circular temples, which we may look upon as the prototype of one of the most magnificent of all Roman buildings, viz., the Pantheon (Fig. 12).

The amphitheatre was also a type of building of which they were the first builders, but as one only exists now, viz., that at Sutri, which is cut in the rock, like many of the Greek examples, we can deduce nothing of its architectural qualifications.

In their utilitarian work, such as roads, bridges, and aqueducts, they occupied the highest position, and the Romans, eminently a practical people, certainly derived their first experiences in this respect from their Etruscan predecessors.

Adopting the same course as that which we followed in our lesson on Greek architecture, we have first to describe their "orders." In these they followed on the same lines as the Greeks, but changed the Greek forms in accordance with their requirements and taste. They employed them also more in a decorative sense than in a constructive one; that is to say, they used three quarter detached columns side by side or piled them one on the other to decorate the surface or exterior of a building which, constructively, was complete without them.

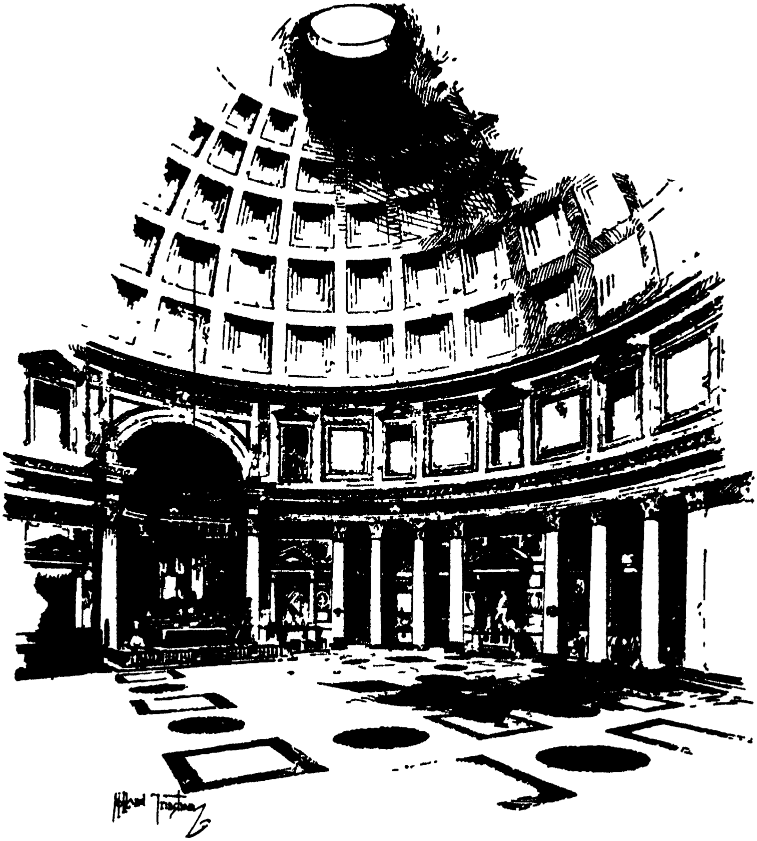


Fig. 12.—The Pantheon, Rome.

Both the Doric and the Ionic order would appear to have been known to the Etruscans, the former by description only; the latter so far as its volutes are concerned is found in tombs, but never as an isolated feature (Fig. 10). It may be for this reason that in their subsequent examples (for it is not found in the earliest example of the Roman Doric order known, that of the theatre of Marcellus) the Romans added a base to the Doric column, suggesting that its early type had been a wooden column. In the place of the subtle hand-drawn mouldings of the capital, base, and entablature they introduced portions of circles which could be mechanically set out. The triglyph, originally a constructive feature placed at the angle of all Greek Doric temples, they placed always in the axis of the columns, leaving, therefore, a portion of a metope at the angle, which was not a constructive arrangement.

The Roman Doric order (Fig. 10, A) is divided, as the Greek, into column and entablature, the former subdivided into base, shaft, and capital, and the entablature into architrave, frieze, and cornice. The shaft was not fluted as in the Greek Doric; in the frieze we find the same decorative divisions of triglyph and metope. The cornice, instead of sloping down, projects horizontally, as also the mutules, which represented originally the roof rafters.

The Roman Ionic order followed very much on the same lines as the Greek. The capital was flattened, and made uniform on all sides; that is to say, the volute at each angle was brought out in a curve, this being done more especially in domestic work. Neither of these orders, however, would appear to have been much employed in Roman monumental work; the Corinthian order (Fig. 10, B), appealed much more to their sympathies, and taking its principal features from the Greek examples, they produced an order which for richness, proportion, and appropriate fitness for the monuments in which it was employed, reached a high standard of excellence. There are two other so-called orders, which we have not yet mentioned, though described by Vitruvius, and which completed the series of the well-known five Roman orders; the Tuscan, however, is only a simplified version of the Doric, and the Composite is, as its name implies, a combination only, viz., of the Ionic volute with the foliage of the lower part of the Corinthian capital. Before proceeding to our description of the Roman buildings, there still remains another combination to be pointed out, which in a sense constitutes a new order; that is to say, an arrangement of forms regulated by definite laws of proportion, and which was applied to Roman buildings very much in the same way as the orders. The construction referred to is that of the arcade between columns; it is, in fact, a mixture of the trabeated and arcuated styles, using the term style only in a constructive sense. The two columns of the order in this case are placed so wide apart that it would be impossible for them to support an entablature. To meet this exigency, the open space is filled in with an arch, the columns being semi-detached only from the wall; being no longer independent features, but forming part of the wall construction. Again, when the orders were superimposed—*i.e.*, placed one above the other—it became necessary on the upper storeys to have a balustrade, and this would seem to have led to the introduction of a new feature, in a pedestal below the column which might range with the balustrade. This combination was employed so frequently in their amphitheatres and palaces that by tradition and usage it became an order. The mouldings round the arch constitute a new classic feature known as the archivolt, and the piers which carry the arches are called imposts, the mouldings which crown them being impost mouldings. In later periods of Roman art, as at Spalato, the attached column was omitted, and the impost (diminished in width) was developed into a column with a capital to carry the arch.

We may now proceed to the principal buildings which constitute the Roman style. Of Roman work there still exists in all parts of Europe and West Asia a vast number of buildings of every description, so that we are not only able to form a just conception of the splendour, the vast resources, and the varied requirements of the Roman people, but to trace the enormous influence which their remains have exercised on succeeding styles. As all the wealth of science and art of the universe was poured into the lap of Rome, so that she may be said to have become the capital of the civilised world; so, through her colonies and dependencies, she became the dispenser of that wealth, and through the greater portion of Europe, in North Africa, and in West Asia, the monuments which she erected in all parts of her dominions have become the models on which succeeding styles have based their first conceptions.

TEMPLES.

The temples of the Roman Empire cannot be considered to set forth the architectural development of the style as we found to be the case in Grecian architecture. The examples existing in Rome are few, and of these so little remains that it is difficult to determine with accuracy their original plan (Fig. 11).

No trace remains of the great temple of Jupiter on the Capitol, originally an Etruscan structure, and subsequently rebuilt and largely added to. Of the temple of Jupiter Stator, now recognised as that of Castor and Pollux, there remain three columns only, carrying an entablature, the total height of which is 60 feet 6 inches. The proportions of the column, the rich foliage of the capital, and the enrichment of the frieze and mouldings, though wanting that refinement and excellence of carving which is characteristic of Greek work, are all of a very high standard, and probably due to the employment of Greek artists in their design and execution. The temple, with eight columns in front, was placed on a position or base 22 feet high, with a flight of steps in front facing the Forum. From this and other examples we gather that the Romans adopted the portico of the Greek temple, giving it, however, a greater depth; that they occasionally carried the peristyle on the two flanks, leaving the exterior of the cella wall plain: in other words, the Roman temple was no longer intended to be seen on all sides, and can only be looked upon as adding a rich and imposing façade to the Forum enclosure. The cella was increased considerably in width, and there being no other chambers, the whole structure was nearly square in plan. The temple of Antoninus and Faustina, also in the Forum, had a magnificent portico of eight columns in front, but no peristyle, its technical description being octastyle pseudoperipteral. The best preserved temple in Rome is that of Fortuna Virilis, with a deep portico of five columns in front, of the Ionic order, and this is also pseudodipteral. Curiously enough, the most perfect examples of the Roman Corinthian temple are those found in her colonies. In the Maison Carrée at Nismes, in the south of France, we find a typical specimen, with six columns in front, the portico being three columns in depth, it being understood in this and in other cases that the Roman portico is an open vestibule with no other columns than those which form its enclosure. The temple is pseudoperipteral, that is to say, there is no peristyle; the flank walls and the rear are, however, subdivided and decorated with semi-detached columns, which therefore serve the purposes of buttresses to strengthen those walls. The temple of Diana, in the same city, is interesting as foreshadowing the plan of a later type of building; the columns (excepting the portico) are placed inside the cella, and two aisles are added, both of these arrangements being contrived to resist the thrust of the circular stone vault with which it is covered. The temples of Venus and Roma in the Forum of Rome were also vaulted with semi-circular barrel vaults, and these two temples, which were placed back to back, are supposed to have been surrounded with an immense peristyle. The most perfect example of this class is the temple of Jupiter at Baalbek in Syria, the greater portion of which still exists, excepting the semicircular stone barrel vault, which has fallen in. The temple measured 117 feet by 227 feet, rather larger, therefore, than the Parthenon at Athens. But the dimensions of this temple were far exceeded by those of the great temple in the same Acropolis, of which six columns only remain erect. This measured about 160 feet by 290 feet. Other temples exist in the ruined cities of Syria, Asia Minor, and the north of Africa; but only the great temple of Jupiter Olympius at Athens—completed at least by Hadrian, 113 A.D.—calls for remark. This temple, of the Corinthian order, was built in white Pentelic marble. It was of the type known as octastyle dipteral—that is to say, it had eight columns in front and back and a double peristyle of columns on the flanks. Owing to a misconception of Vitruvius' meaning, it was considered to have had ten columns in front, but the researches of Mr. Penrose in 1884 proved that they could only have been eight, and that it occupies the centre of a large enclosure, the substructure of which still remains. The temple measured 350 feet in length

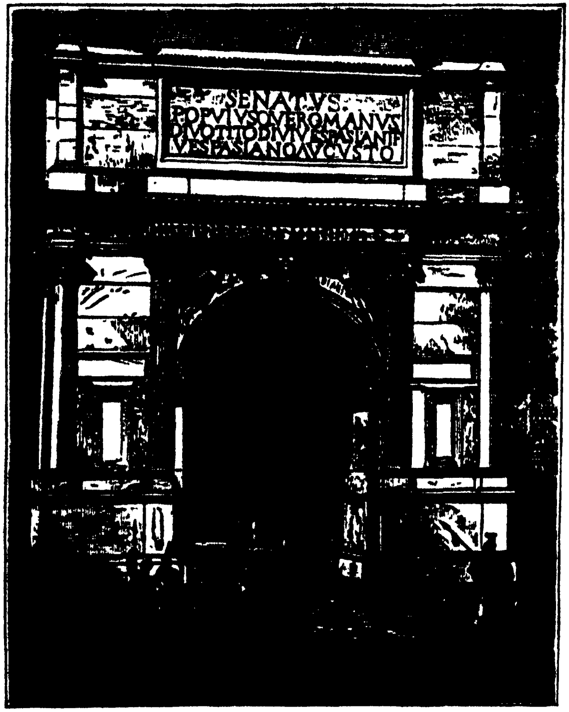


Fig. 13.—Arch of Titus, Rome.

by 140 feet wide, there being 106 columns in its portico and peristyle, all about 58 feet in height.

We have already pointed out that some of the earlier forms of Etruscan temples were circular. There are two Roman examples, the temples of Vesta in Rome and at Tivoli, both being enclosed in circular peristyles. The most remarkable circular temple in existence, however, is that known as the Pantheon (Fig. 12), so unusual a form for a temple that it has been thought by some to be the original caldarium of the baths of Agrippa, which are situated in the rear: no openings are found between the two, however, nor have the special means required for heating such a hall ever been found; moreover, the immense circular opening in its roof, 30 feet in diameter, seems to disprove it. The portico which leads to it is known to be of the time of Agrippa, but whether it is coeval with the circular hall, or added to it afterwards, it is difficult to determine. The latter would seem the more probable, except for the fact that no mention is made of the building by Vitruvius, and it scarcely seems possible that so magnificent a structure should have existed in his time—magnificent not only in its conception but in the extraordinary scientific knowledge displayed in its construction—without its beauties being dwelt upon by that author. The dome with which it is covered is 143 feet in diameter and 147 feet in height, and the walls are 20 feet thick. The roof is vaulted with twenty-four brick ribs tied together by flat arches, and forming a series of coffers, which were originally covered with bronze plates, taken away and melted down by one of the Popes to form the great baldachino in St. Peter's. The portico with eight columns in front of the Corinthian arch is one of the finest examples in Rome, both in its general proportions and the severity of its decoration.

THEATRES AND AMPHITHEATRES.

The next class of buildings we propose to describe are those which would appear also to have been derived from the Etruscans, though never carried out to the same extent by that people—viz,, the theatres and amphitheatres. Of the former, that of Marcellus in Rome only exists, there being, however, a fine example at Orange in the south of France. The theatre of Marcellus is too much destroyed for its interior arrangement to be made out. Its exterior, at least the circular portion of it, in two storeys, and decorated with the Doric and Ionic orders superimposed with arcades between, is the purest example of Roman architecture. Of amphitheatres there are many examples, not only in Italy—at Rome, Verona, Capua, and Pompeii—but in the south of France, at Arles and Nismes, at Pola in Istria, and elsewhere. The finest is that known as the Colosseum or the Flavian amphitheatre in Rome. Its plan is that of an ellipse 620 feet in its greater diameter, by 513 feet, the total area being 250,000 square feet, of which the arena covers 40,000 square feet. The seats are arranged in rising tiers, the topmost being protected by a portico round the whole interior. The entrances to the building exist all round, leading to passages and staircases rising to these various levels. The total height of the building is 157 feet, and is divided into four storeys, the three lower decorated with the Doric, Ionic, and Corinthian orders, superimposed with arched openings between each; the upper storey (behind the peristyle or interior portico), decorated only with pilasters and, at the top, the stone brackets and holdfasts intended to hold the masts of the velarium which during the performances was extended across the vast open space. Various estimates have been made of the number of spectators it could accommodate, about 50,000 to 60,000 being the most probable. Excavations were made beneath the arena some fifteen years ago, which displayed a network of passages and chambers, in which the wild animals were located, and also certain contrivances which suggested that the whole arena could be flooded with water, affording the unusual display of a sea-fight. The amphitheatre at Nismes, which has been partially restored, is built with seats of marble, and, as in that at Verona, is still used for displays of various kinds.

THERMÆ OR BATHS.

The great typical class of building which contains to the fullest extent all the finest qualities of Roman architecture are the great *thermæ* or baths which the emperors vied with one another in erecting, to meet the favour of that vast class of opulent and idle people who lived upon the wealth and the treasures of the conquered nations. They contained not only baths in the ordinary acceptance of the term (of that description known as Turkish baths), but—these were placed in halls of such size and magnificence that they became the lounge of the Roman people—some of the finest Greek sculptures have been found in them, which show that they served as museums in a sense; they were decorated with paintings on the internal walls, and with mosaic pictures on the exterior, and contained courts with porticoes of columns of the rarest marbles, with which also their walls were lined. These baths included porticoes and open courts for athletic exercises of every kind, and halls and lecture rooms, where the poets and literati of the day could recite their verses and their literary compositions.

They comprised, in fact, the club (except that there was no restaurant), the museum, picture gallery, gymnasium, lecture hall, promenade—in fact, all those attractions which are occasionally found in some of our bathing establishments such as at Harrogate or Bath, where, partially for the sake of health, partially to pass the time, English people assemble at certain periods of the year.

Of the baths of Agrippa, Nero, Vespasian, Domitian, Trajan, and Constantine very little remains, but many of their plans are known, having been measured and drawn by Palladio in the 16th century. The great hall or tepidarium of the bath of Diocletian still exists in the church of Santa Maria degli Angeli, and the general plan of the great Thermæ of Caracalla has been carefully measured, and restored in drawings, which are so far reliable that they give us some fair idea of the splendour and magnificence of these great establishments.

The general enclosure of the baths of Caracalla measured about 1,150 feet square, and was raised on a platform to which one ascended by flights of steps; round the enclosure were porticoes, gymnasia, and lecture halls; and at the back, what we should call a grand stand, from which the spectators could watch the races and gymnastic exercises in an arena. In the middle of the enclosure was the principal building, measuring 730 feet by 380 feet, containing the vestibules, dressing-rooms, halls for various kinds of games, and the three great halls of the baths—the *caldarium*, or hot bath, the *tepidarium*, or warm room, and the *frigidarium*, or cold bath. The latter was open to the sky but surrounded with porticoes. The tepidarium was the central hall where the chief assemblages took place. It was 179 feet long, 82 feet wide, and about 120 feet in height It was vaulted in brick or concrete, the vault being decorated with coffers or sunk panels and mosaics. The hall, being much loftier than the halls adjoining, was lighted by windows on the two sides and the ends. The caldarium was a circular hall, around which was a dome similar in many respects to the Pantheon, being about 120 feet in diameter, which was probably lighted by small side windows, fitted with glass to retain the heat in the hall. Other courts and halls completed the central building, which covered a space about equal to our Houses of Parliament. The walls, floors, and vaults were covered with paintings, mosaics, richly coloured marbles of every kind, which must have formed one of the most magnificent interiors ever conceived. The magnificence of the vault and wall decoration of the baths of Titus, which were excavated during Raphael's time, are said to have inspired his decoration of the loggia of the Vatican.

BASILICAS.

Historically speaking, the basilicas are of greater importance than any other Roman buildings: owing, however, to their having been roofed in timber, liable to destruction by fire, whilst their columns were easily removed and made use of in the erection of Christian basilicas, there are only two of which the plans have been found, viz., the basilica Julia in the Forum, and the Trajan basilica in the forum of that name. A basilica, or court of justice, consisted of a central hall surrounded by aisles or porticoes, sometimes with galleries, sometimes without. This portion served as the exchange or meeting-place of the merchants; at the back, and separated from it by the aisles or porticoes, was a semicircular apse which constituted the hall of justice. The central hall was lit by clerestory windows above the aisles, or galleries, if any, and in Rome was roofed over with a timber roof. (The basilica at Pompeii was open in the centre.) The aisles were lit by side windows.

It was probably owing to the easy destruction of these timber roofs that at a later period the basilica of Maxentius, finished by Constantine, the remains of which still overlook the Forum, was built in brick and concrete; the form adopted being that description of hall which we find in the tepidarium of the Roman baths. The basilica was a feature found also in the large palaces or mansions of the nobles, where it served the purpose of a small court of justice or a hall from which the senator addressed his followers.

ARCHES AND BRIDGES.

Triumphal arches built to welcome a conqueror on his return home with spoils are found not only in Rome but throughout her colonies. At Rome we have the arches of Titus (Fig. 13), Septimius Severus, and Constantine; of Trajan at Beneventum, at Ancona, at Treves in Germany, at Orange and Rheims in France, as well as other examples in North Africa and Syria.

Of bridges and aqueducts there are three in Spain—Segovia, Alcantara, and Tarragona; and one celebrated example, the Pont-du-Gard, near Nismes in France; and the finest and most ancient roads found throughout Europe and elsewhere are those which were laid by the Romans.

Not only in the vicinity of Rome but outside Pompeii and other Roman cities are still found remains of tombs which show that their respect for the dead was far greater than that at the present day, for not only did they lavish on them all that the artistic genius of the nation could conceive, but by placing them immediately outside their cities in the main roads they were constantly kept in view by the passers by.

DOMESTIC ARCHITECTURE.

So great has been the destruction in Rome of the many palaces and public monuments, even within the first three centuries of our era, and of course much more so since, that it is very difficult even to trace the plans of some of the more important which were known to have existed; though it is impossible to make excavations anywhere in the Sacred City without coming upon strata after strata of houses erected at various periods. To study her domestic architecture, therefore, we have to go to Pompeii, a second- or even third-rate city, perhaps, but which by a provision of nature has been preserved in great part down to our own day. It is true that all the roofs and vaults are gone, and of the walls only from 10 to 12 feet remain, but with these and the descriptions of various authors it is possible to reconstruct in our imagination the general appearance of the city before it was overwhelmed by the last fatal eruption of Vesuvius in the year A.D. 79, which buried the city in a shower of ashes, pumice, and stone, in a layer 12 to 14 feet deep. Of the temples and other public buildings it is not worth speaking, as they are of far less importance than those in Rome and elsewhere, but of the private houses and villas of the upper and lower classes there exists an inexhaustible supply, from which the following general arrangements can be summarised.

The more important houses were divided into two parts, the public and the private portion. Of the former an entrance vestibule led to the atrium, a large hall open in the centre to the sky, the covered portion having a roof sometimes supported by columns surrounding the impluvium (a marble basin under the compluvium or open space in the roof). Round the atrium and lighted from it were a series of chambers, sleeping-rooms for the male guests, recesses for conversation, and the *tablinum* or sitting-room. The private portion consisted of a peristyle round an open court in which there was a small garden, the *triclinium* or dining-room, the *pinacotheca* or picture-room, the *bibliotheca* or library, and suites of small chambers used as bedrooms. Besides these there was generally a court surrounded by the offices, the kitchen, bakehouse, and store-rooms. All these rooms derived their light from the internal courts, the exterior of the block forming the house being invariably occupied by shops, in which sometimes the lord of the mansion kept retainers who sold the produce of his farms and lands.

From the walls which still remain erect we ascertain that they were all richly decorated in colour, painted in arabesque, and occasionally with landscapes, figure subjects and wreaths of flowers; the columns were of marble or painted in imitation, and the floors inlaid with mosaic or with small pieces of marble set in cement. The roofs, being all in wood, have perished, but their coverings in tiles with the various ornaments on the ridges of the roof are still found in the excavations. Such portions of Herculaneum, a town close by, as it has been found possible to excavate (the lava which overwhelmed it being of great hardness), shows even finer work than at Pompeii, and those remains which occasionally are found in Rome show a far higher quality of work than that found in either of these cities.

ALGEBRA.—XIX.

[Continued from Vol. VI., p. 344.]

MISCELLANEOUS EXAMPLES FOR PRACTICE.

292. We now offer to our readers as a useful supplement to our lessons two exercises of miscellaneous examples, covering the whole ground treated.

EXERCISE 77.

1. If $a = 8$, $b = 7$, $c = 6$, $d = 5$, and $e = 1$, prove that $(ab + ce - bd) + \left(\frac{a+b}{c-e} + \frac{3b-2c}{a-d}\right) = 3a - 2b + 4c - e$.

2. Also prove that $\sqrt{(a^2 - 3d)} \times \sqrt[3]{(b^3 - c^3 - 2e)} = (d^2 + (a - c) - 3ce^2 + d^3) - \sqrt[3]{a(ab + d)}$.

3. Prove that $\frac{(a+b) - (a-b)}{2} = 1 - \left\{1 - 1 - \overline{1 - b}\right\}$

4. Prove that $\frac{(a+b) + (a-b)}{2} = -\left[-\left\{-(-a)\right\}\right]$.

5. Find the value of $\frac{a^2+b^2}{a^2-b^2} \pm \frac{a-b}{a+b}$.

6. Find the value of $\frac{2a}{a^4-b^4} + \frac{1}{a+b} - \frac{1}{a-b}$

7. Find the value of $\frac{1}{(a-b).(a-c).(x+a)} - \frac{1}{(a-b).(b-c).(x+b)} + \frac{1}{(a-c).(b-c).(x+c)}$

8. Find the value of $\frac{1}{4a^3(a+x)} + \frac{1}{4a^3(a-x)} + \frac{1}{2a^2(a^2+x^2)}$.

9. Divide $1 + 2x$ by $1 - x - x^2$.

10. Simplify the following fraction: $\dfrac{\frac{a}{ab} + \frac{b}{a+b}}{\frac{a}{a-b} + \frac{b}{a+b}}$

11. Find the value of $\frac{1 - 3x - 2x^2}{1 - 4x}$.

12. Add $\frac{2}{2x+1}$, $\frac{3}{3x-2}$, and $\frac{-8}{4x+3}$ together.

13. Divide $\frac{a}{a-b} + \frac{b}{a+b}$ by $\frac{a}{a-b} - \frac{b}{a+b}$.

14. Extract the square root of $x^2 + \frac{1}{x^2} + 2\left(x - \frac{1}{x}\right) - 1$.

15. Extract the square root of $x^2 - xy + 2x + \frac{1}{4}y^2 - y + 1$.

16. Extract the cube root of $8\frac{a^3}{b^3} + 36\frac{a}{b} + 54\frac{b}{a} + 27\frac{b^3}{a^3}$

17. Find the cube root of $125a^3 - 300a^2b + 240ab^2 - 64b^3$.

18. Simplify $\sqrt[4]{32x} + \sqrt[4]{162x} - \sqrt[4]{512x}$.

19. Simplify $\sqrt{(a^2b - 6ab + 9b)} + \sqrt{9b}$.

20. Simplify $\sqrt{a^3 - \sqrt{(a^6 - x^6)}} \times \sqrt{a^3 + \sqrt{(a^6 - x^6)}}$.

21. Find the continued product of $(a+b)^{\frac{1}{m}}$, $(a-b)^{\frac{1}{n}}$, $(a+b)^{\frac{1}{n}}$, and $(a-b)^{\frac{1}{m}}$.

22. Multiply $x + 2y^{\frac{1}{2}} + 3z^{\frac{1}{3}}$ by $x - 2y^{\frac{1}{2}} + 3z^{\frac{1}{3}}$.

23. Simplify $\frac{x + \sqrt[3]{(xy^2)} - \sqrt[3]{(x^2y)}}{x+y}$.

24. Simplify the following fraction: $\sqrt{\left\{\left(\frac{a^{-2m}}{b^{-3n}}\right)^{\frac{p}{m}}\right\}^{\frac{1}{n}}}$.

25. Add together the fractions
$\frac{\sqrt{(x^2+1)}+\sqrt{(x^2-1)}}{\sqrt{(x^2+1)}-\sqrt{(x^2-1)}}$ and $\frac{\sqrt{(x^2+1)}-\sqrt{(x^2-1)}}{\sqrt{(x^2+1)}+\sqrt{(x^2-1)}}$.

26. Find the greatest common measure, and then reduce to its lowest terms $\frac{4x^2-12ax+9a^2}{8x^3-27a^3}$.

27. Reduce to their lowest terms the fractions
$\frac{a^4+a^3b+ab^3+b^4}{a^4+3a^3b+4a^2b^2+3ab^3+b^4}$ and $\frac{a^4+a^3b+ab^3+b^4}{a^4-3a^3b+4a^2b^2-3ab^3+b^4}$.

28. Prove that $\frac{1}{x(x-y)(x-z)} + \frac{1}{y(y-x)(y-z)} + \frac{1}{z(z-x)(z-y)} = \frac{1}{xyz}$.

29. Prove that $\frac{a^2+a+1}{(a-b).(a-c)} + \frac{b^2+b+1}{(b-a).(b-c)} + \frac{c^2+c+1}{(c-a).(c-b)} = 1$.

30. Which is greater, n^3+1, or $n+n^2$? and which is greater, $x^{\frac{2}{3}} - 1$, or $(x-1)^{\frac{2}{3}}$.

31. If $240m = (12p+q)n$, show that £$\frac{m}{n} = ps + qd$, and take the case when $m = 2$, and $n = 3$; $p = 13$, and $q = 4$.

32. Multiply $2a + 3b\sqrt{-1}$ by $3a - 2b\sqrt{-1}$.

33. Show that $\frac{a+b\sqrt{-1}}{a-b\sqrt{-1}} = \frac{a^2+2ab\sqrt{-1}-b^2}{a^2+b^2}$.

34. Prove that $\frac{c^2(a+b)^2+c^2(a-b)^2}{2c^2} = (a+b\sqrt{-1}) \times (a-b\sqrt{1})$.

35. Find the sum and difference of $\sqrt{(x^3+2x^2y+xy^2)}$ and $\sqrt{(x^3-2x^2y+xy^2)}$.

36. Reduce a, $a^{\frac{1}{2}}$, $a^{\frac{1}{3}}$, and $a^{\frac{1}{4}}$ to equivalent quantities having the same index; also $x^{\frac{2}{3}}$, $y^{\frac{3}{4}}$, and $z^{\frac{1}{6}}$.

37. Divide $\frac{a-\sqrt{(a^2-b^2)}}{\sqrt{(a^2+b^2)}+b}$ by $\frac{\sqrt{(a^2+b^2)}-b}{a+\sqrt{(a^2-b^2)}}$, and $x^{\frac{1}{2}} - a^{\frac{1}{2}}$ by $x^{\frac{1}{3}} - a^{\frac{1}{3}}$

38. Multiply $\sqrt{(x+2)}+1$ by $\sqrt{(x+2)}-1$.

39. Divide $4x^{\frac{5}{3}} + 14x - 9x^{\frac{4}{3}} - 19x^{\frac{2}{3}} + 4x^{\frac{1}{3}}$ by $x^{\frac{4}{3}} - 2x^{\frac{3}{3}} + 3x^{\frac{2}{3}} - 4$.

40. Prove that $x^7-x^6-x^5+x^4-x^3+x^2+x-1 = (x^4-1).(x^3-x^2-x+1) = (x^2+1).(x+1)^2.(x-1)^3$.

41. Find a fraction which, taken $\frac{a^m}{a^n} - 11y^2$ times, shall produce $11y^2+z^3$.

42. What fraction multiplied by $\frac{3}{5}x^2$ will produce x^{-m}?

43. Find the product of $\frac{x^my^n}{c^2}$ by $\frac{x^{n1/m}}{z^3}$, and show the result in one line.

44. Find by the binomial theorem the 8th power of $1 - x^{\frac{1}{2}m}$.

45. Express in a *general form* the 11th term in the mth power of the binomial $x+y$.

46. Find the 4th root of a^2b^6x, and the 5th root of $-32xy^5z^n$.

47. Find the nth root of $-\frac{x^{2n}y^{mn}}{v^2z^{\frac{1}{n}}}$ where n is an odd number.

48. Find the cube root of $x^6+9x^5+6x^4-99x^3-42x^2+441x-343$.

49. Express $-2x^2$ in the form of the 5th root, and $3x^{2m}$ in the form of the $\frac{3}{4}$th power.

50. Prove that $\left(a^{-\frac{m}{n}}\right)^{-\frac{p}{q}} = \sqrt[nq]{a^{mp}}$; $\left[\left(a^{\frac{1}{4}}\right)^{\frac{1}{5}}\right]^{-\frac{1}{2}} = \sqrt[40]{\frac{1}{a}}$; and $\sqrt[4]{\left(\frac{a\sqrt{b}}{\sqrt[3]{ab}}\right)^3} = \sqrt[8]{a^4b}$.

51. Find the value of $\left(\frac{2ac}{b^2} + \frac{1}{4}bc^2d\right)^2$.

52. Find the two middle terms of $(a-b)^{17}$ by the binomial theorem.

53. Find the ninth term of $(2ab - cd)^{14}$.

54. Find the fourth term of $(a-b)^{100}$.

55. Given $\sqrt{d} - \sqrt{x} = \sqrt{dx}$, to find x.

56. Given $17x^2 - 21 = x^2 + 23$, to find x.

57. Find the value of x in the following equation: $\frac{2}{7}x^{\frac{1}{2}} - 7 = -5$.

58. Given $\sqrt[4]{2\sqrt[3]{x^3-7}} = \sqrt{2}$, to find x.

59 Given $\sqrt[3]{7x^{\frac{1}{2}} - 4} = -2$, to find x.

60. Given $2a^2(a^2+x^2)^{-\frac{1}{2}} = x + \sqrt{a^2+x^2}$, to find x.

61. Given $\sqrt[3]{x^2-2} : \sqrt[3]{x^4+x} :: \sqrt[3]{x}\ \ x$, to find x.

62. Given $2\sqrt{x} + \frac{1}{4}y - 18 = \sqrt{x} - \frac{1}{4}y + 9$, and $9\sqrt{x} + \frac{3}{4}y - 10 = \frac{1}{2}\sqrt{x} + \frac{1}{2}y + 72$, to find x and y.

63. Given $7\sqrt{x} - 2\sqrt{y} = \sqrt{y} + 15$, and $4\sqrt{x} - \sqrt{y} = \sqrt{x} + 7$, to find x and y.

64. Given $\frac{1}{2}x - \frac{1}{3}y = 3$, and $\frac{1}{3}x + \frac{1}{4}y = 14$, to find x and y.

65. Given $(x+4).(y-2) = xy$, and $(x-3).(y+5) = xy$, to find x and y.

66. Given $\sqrt{x-2} + 5\sqrt[3]{y+3} = 23$, and $\frac{3}{4}\sqrt{x-2} - 3\sqrt[3]{y+3} = -8\frac{1}{4}$, to find x and y.

67. Given $2x^2 + 3y^2 = d$, and $x \cdot y :: 2a : c$, to find x and y.

68. Given $xy = 20$, and $x^2 + y^2 = 41$, to find x and y.

69. Given $x + y = 25{\cdot}5$, and $xy = 57{\cdot}5$, to find x and y.

70. Given $x - y = 2$, and $x^3 - y^3 = 98$, to find x and y.

71. Given $x + y = 18$, and $x^2 + y^2 = 170$, to find x and y.

72. Given $x + y = 34$, and $x^3 + y^3 = 27064$, to find x and y.

73 Given $x - y = 7$, and $\frac{x^2}{y} - \frac{y^2}{x} = 82\frac{1}{8}$, to find x and y.

74. Given $6x^2 - 17xy + 12y^2 = 28$, and $2x - 3y = 4$, to find x and y. (N B. Divide the first equation by the second.)

75 Given $x + y = 7$, and $x^2 - y^2 = 21$, to find x and y.

76. Given $x + y - z = 17$, $2x - 2y + z = 9$, and $3x - 4y - z = 4$, to find, x, y, and z.

77. Given $x + y + z = 117$, $x - y - z = 63$, and $x - y + z = 105$, to find x, y, and z.

78. Given $10x - \frac{1}{2}y + \frac{1}{3}z = 50$, $4x + 2y - \frac{1}{4}z = 22\frac{1}{2}$, and $3x - 3y - 3z = 0$, to find x, y, and z.

79. Given $xy = 40$, $xz = 10$, and $yz = 16$, to find x, y, and z.

80. Given $x^2y^2 = 144$, $x^2z^2 = 225$, and $y^2z^2 = 400$, to find x, y, and z.

81. Given $3x - 2y + \frac{1}{2}z + w = 8$, $x + \frac{2}{3}y + z - \frac{1}{2}w = 4$, $2x - 4y + \frac{1}{3}z + 2w = 5$, and $\frac{1}{2}x + \frac{2}{3}y + \frac{3}{4}z - 3w = 0$, to find w, x, y, and z.

82. Given $x + y - z - v + w = 0$, $2x - 3y - z + 5v - 6w = 33$, $3x + 7y + 3z - 4v + 5w = 62$, $\frac{1}{2}x - \frac{1}{3}y + \frac{1}{4}z - \frac{1}{5}v - \frac{1}{6}w = 4$, and $4x - 4y - 4z + 10v - 8w = 92$, to find v, w, x, y, and z.

83. Given $x^2 + x + 2y^2 = 24$, and $2x^2 - y^2 = 1$, to find x and y.

84. Given $x\sqrt{5 + x^2} = x^2$, to find x.

85. Given $2x^6 - 4x^3 + 3 = 99$, to find x

86. Resolve 8 into two factors, whereof the sum of the 5th powers may be 1056.

87. Given $x^2 + xy + y^2 = 52$, and $x^2 - xy = -8$, to find x and y.

88. Given $x(x+z) = 104$, and $3(x-z)z = 45$, to find x and z.

89. Given $x^2 + z^2 = x^3 - z^3$, and $x^2 - z^2 = xz$, to find x and z.

90. Given $x^4 - x^2y^2 + x^3y - xy^3 = 405$, and $x^2 + xy = 45$, to find x and y. (N.B. Divide the former by the latter.)

91. Given $x + y = 10$, and $x^4 + y^4 = 1552$, to find x and y.

92. Given $x + y = 7$, and $x^5 + y^5 = 3157$, to find x and y.

93. Given $x - y = 4$, and $x^4 - y^4 = 2320$, to find x and y.

94. Given $x - y = 2$, and $\frac{x^4}{y} - \frac{y^4}{x} = 124$, to find x and y.

95. Given $x + y = 11$, and $\frac{x^4}{y} + \frac{y^4}{x} = 779\frac{11}{18}$, to find x and y.

96. Given $x - y = 2$, and $\frac{x}{y} - \frac{y}{x} = 1\frac{1}{15}$, to find x and y.

97. Given $x + y = 5$, and $xy = 6$, to find $x^7 + y^7$ without finding x and y.

98. Given $x - y = 11$, and $xy = 26$, to find $x^3 - y^3$ without finding x and y.

99. Given $x^4 - 2x^3 + x = 132$, to find x by quadratics.

100. Given $x^8 - 2x^6 + x^4 = 359400$, to find x by quadratics.

EXERCISE 78.

1. Given $x^4 + \frac{1}{2}x^3 = 28\frac{1}{2}x$, to find x by quadratics.

2. Given $x : y : : y : z$, $x + y + z = 42$, and $x^2 + y^2 + z^2 = 1092$, to find x, y, and z.

3. What number is that, the double of which is as much above 40 as its half is below it?

4. A had £80, and B £30. B gave away a certain sum, and A twice as much; and then A had 3 times as much as B had. What did A give away?

5. Tea at 5s. 3d. per lb. is mixed with tea at 4s. 3d. per lb., and 10 lb. of the mixture are sold for 44s. 6d. How much was there of each?

6. Divide £153 between A and B, giving B $1\frac{1}{4}$ times A's share.

7. Divide 77 into two parts, such that the sum of the quotients of the one by 4, and the other by 11, shall be 14.

8. A father's age is 49, and the son's is 11; in how many years will the father's age be treble the son's?

9. A farm of 2,850 acres is divided between three sons (A, B, and C), so that A's share is to B's as 6 : 11; and C has 300 acres more than A and B together. Find their shares.

10. A garrison consists of 2,080 men, of which there are 9 times as many foot soldiers and 3 times as many artillerymen as cavalry. Find the number of each.

11. A bill of £7 19s. has been paid with 51 coins; some are crowns, the rest are florins. Find the number of each.

12. There is a number of 2 digits; their sum is 10, and if these digits be transposed, we obtain a number greater by 15 than 4 times the original number. Find the original number.

13. The sum of two numbers is 23, and 3 times their difference is 21. Find the numbers.

14. Sold a watch for £24, and by so doing lost as much per cent. as the watch cost. Find the cost of the watch.

15. The area of a triangle is 6 square feet, and the base is known to be 3 times the height. Find the base and height.

16. Compound the ratios of $b^3 : b^3 - x^3$, $b + x$ $b - x$, and $b^3 - x^3 : b^3$.

17. Show that $\sqrt{11} + \sqrt{7}$ is greater than $\sqrt{19} + \sqrt{2}$.

18. Which is greater, $\sqrt{5} + \sqrt{14}$ or $\sqrt{3} + 3\sqrt{2}$?

19. Show that the ratio compounded of $a : x$, $x : y$, and y b, is the same as the ratio compounded of $x + a : x + b$, and $a(x + b) : b(x + a)$.

20. Find the number to which if 2 and 5 be successively added, the resulting numbers are in the proportion of 3 : 8.

21. Find two numbers in the proportion of 3 : 4, and their sum : the sum of their squares as 7 : 50.

22. Find the 64th term of the series 4, $6\frac{1}{2}$, 9, etc.

23. Find the 7th term, and the sum of 7 terms of the series $\frac{1}{2}$. $\frac{1}{4}$, $\frac{1}{8}$, etc.

24. Find the sum of $5 + 4\frac{2}{3} + 4\frac{1}{3}$, etc., to 21 terms

25. How many terms of the series 19, 18, 17, etc., amount to 124?

26. Two hundred stones are placed at the distance of a yard from each other, in a right line with a basket, which is one yard from that next to it. A person starts from the basket, and brings them one by one into it. What space does he travel over?

27. Insert 4 arithmetical means between 5 and 6.

28. Given the first term of an arithmetical series = 2; and the sum of 17 terms = 102. Find the common difference.

29. The first term of an arithmetical series is 3; the 13th term is 55. Find the common difference.

30. The sum of three numbers in arithmetical progression is 21, and the sum of their squares 179. Find them.

31. Find the 8th term, and the sum of 8 terms, of the geometrical series 81, − 27, 9, etc.

32. Find the sum of 3, − 6, + 12 −, etc., to 6 terms.

33. Find the limit of the sum of the series $1 + \frac{1}{4} + \frac{1}{16}$, etc.

34. Find a geometrical series whose 1st term is 2, and 7th term is $\frac{1}{32}$.

35. Insert 3 geometrical means between 2 and $10\frac{1}{8}$.

36. The perimeter of a piece of ground in the form of a right-angled triangle = 96 rods, and the radius of its inscribed circle = 44 yards. Find the sides of the triangle, the area of the inscribed circle, and the area of the ground.

37. If a candle, in the form of a cone 12 inches high, burns 12 hours, and the bottom inch burns 1 hour longer than the top one, what time will the fourth inch from the top burn; and also find the time the top inch will last?

38. At what height must a person be to see $\frac{1}{15}$ of the earth's surface, supposing it to be perfectly spherical, and its diameter 7,960 miles?

39. Given $\frac{x^4 + 1}{(x + 1)^4} = \frac{1}{2}$, to find x.

40. Given $\frac{x^2 + 1}{a^2 + 3ab + b^2} = \frac{2x}{a^2 + ab + b^2}$ to find x.

41. Given $x^2 = \sqrt{x^2 - 1} + \sqrt{x^4 - 1}$, to find x by quadratics.

42. Given $3x + 5y = 78$, to find integral values of x and y.

43. In how many ways may £80 be paid with sovereigns and guineas?

44. What number is that which, if divided by 5, 7, and 9, leaves the remainders 1, 1, and 0.

45. Divide 150 into three parts, so that one of them being divided by 9, another by 7, and the other by 2, the quotients will together amount to 25.

46. What number is that which when divided by 2, 3, 4, 5, etc., to 12, has for its remainder 1 less than its divisor?

47. How must I mix three kinds of spirits at 2s. 4d , 2s. 6d., and 3s 4d. per gallon, to make 100 gallons at 3s.?

48. Find the side of a square, inscribed in a given semicircle, whose diameter is (a).

49. Find the side of an equilateral triangle, inscribed in a circle whose radius is (a), and that of another circumscribed about the same circle.

50. Find the sides of a rectangle, the perimeter of which is equal to that of a square whose side is (a), and its area equal to $\frac{1}{2}$ the area of the square.

51. An ingot of gold was sold at a loss for £420. If it had been sold for £570, then the gain would have been exactly 4 times as much as the loss is at present What did it cost?

52. Find a number such that when it is added to 15, 27, and 45, there arise three numbers which are in geometrical progression.

53. A, B, and C wanted to buy a horse, but neither of them had money enough for the purpose; A begged of B and C the half of their money, in order to enable him to buy it. On the other hand, B asked A and C only for the $\frac{1}{3}$ of their money, because he then would be able to buy it himself; on which C said to A and B, "Lend me $\frac{1}{4}$ of your money each, and then I can buy it." How much money had each, and how much did the horse cost, supposing we know that they had no other money than sovereigns?

54. Five friends, A, B, C, D, and E, jointly spent a certain sum at an inn. This sum is to be paid by one of them, but on counting the sovereigns they had in their pockets (for none of them had smaller coin), no one had enough to pay it alone. If one pay it alone, the others must add a part of their money; so that A must contribute $\frac{1}{2}$; B, $\frac{1}{3}$; C, $\frac{1}{4}$; D, $\frac{1}{5}$; and E, $\frac{1}{6}$ of the others' money. How much did they spend, and how much had each?

55. Find two numbers such that their product is equal to their sum, and their sum, added to the sum of their squares, is equal to $15\frac{3}{4}$.

56. A traveller starts from a certain place, and goes 1 mile the first day, 2 the second, 3 the third, 4 the fourth, etc. Five days after another traveller starts from the same place, takes the same road, and goes 12 miles daily. On what day after the departure of the first will they be together?

57. A bookseller sold me two bound books, the one which contained 48 sheets for 14s., the other of 78 sheets for 19s. The binding and paper were the same in both. What was the price of the binding?

58. A person buys a piece of cloth, and pays £7 for every 5 ells; he then sells every 11 ells for £16, and gains by the bargain £24. How many ells did the piece contain?

59. A sum of £156 was to be divided amongst 16 poor children, in proportion to their ages, in such a way that each of the elder ones received exactly twice as much as the next younger. If, therefore, the youngest according to this division received £6, how much more did each preceding one receive, and how much the eldest?

60. A schoolmaster gave his pupil two numbers to multiply, one of which was greater than the other by 75. When the scholar had finished the multiplication, he proved it; and the product divided by the least factor gave the quotient 227, and remainder 113. The schoolmaster then found that it was multiplied wrong, and ordered the error to be corrected. When the pupil had found out the error, he said that he had calculated only 1 too little in the multiplication. "No," said the master, "not 1; but 1 thousand" What numbers were given to multiply?

61. In a solution of salt and water, the weight of the fresh water $= a$, the weight of the salt $= b$; therefore its contents $= \frac{b}{a+b}$. How much water must be added to it that its contents $= g$?

62. The sum of two numbers = 9, and the sum of their cube roots = 3, Find the numbers.

63. The sum of two numbers $= a$, and the sum of their fourth powers = 14 times the product of their squares. Find the numbers.

64. Find the value of R, in terms of v, r, and H, in the formula $v = \pi(R^2 + r^2 + R + r)\frac{H}{3}$.

65 Find the value of v, in terms of g and e only, from the following: $v = gt$, and $e = \frac{gt^2}{2}$.

66. I offered to buy the nuts a boy had for sale at the rate of 1s. per gross, but he could not say the exact number he had: he, however, remembered that when he counted them over by 2, 3, 5, 7, and 11 at a time, there remained 1, 2, 3, 4, and 5 respectively, and that he expected to make nearly 11s of them. I offered him 10s. 6d. for the lot, which he agreed to. Find how many nuts there were, and whether I gained or lost, and how much.

67. Bought $21\frac{1}{4}$ cwt. of rice at x shillings per cwt., and 324 lb. of Assam tea at y pence per lb. for £59. Find the values of x and y in integers.

68. A fortunate gamester counted the sovereigns he had won twice successively; the first time, having counted them by threes, he had 2 over; the second time he counted by fives, and had 1 over. After this he played again, and lost £6; and then counted the sum left by 7 and 11 at a time, and found he had 3 over each time. How many sovereigns did he win the first time he played?

69. Find two numbers such that the 1st multiplied by 17, and the 2nd by 26, the 1st product is 7 greater than the 2nd.

70. Divide 240 into 3 parts, so that the 1st divided by 8, and the 2nd by 6, and the 3rd by 4, the quotients and remainders are the same in each.

KEY TO EXERCISES.

EXERCISE 76.

1. Base $= \frac{\sqrt{(2h^2 - d^2)} - d}{2} = 6$; perpendicular $= \frac{d + \sqrt{(2h^2 - d^2)}}{2} = 8$.
2. Base = 12 rods, and perpendicular = 16 rods.
3. Length $l = \frac{\sqrt{2d^2 - p^2} + p}{2} = 12$; breadth $b = p - l$.
4. BC $= \frac{d}{a} \pm \sqrt{\frac{d^2}{a^2} - \frac{2hl}{a}}$; from this AB and AC can be found.
5. Hypothenuse $= \frac{s}{2} - \frac{2a}{s}$.
6. DG $= \frac{b}{2} \pm \sqrt{\frac{b^2}{4} - \frac{bc}{a}}$.
7. CD $= 3\frac{1}{3}$; DA $= 6\frac{2}{3}$.
8. x or PR $= \sqrt{ad + \frac{1}{4}d^2} - \frac{d}{2}$, and PQ $= x + d$.
9. 11 feet 4 inches
10. 9.
11. 6.
12. 9, 12 and 15: general solution, $\frac{1}{2}\sqrt{6a}$; $\frac{2}{3}\sqrt{6a}$; and $\frac{5}{6}\sqrt{6a}$.
13. 7 and 14.
14. One of the equal sides $= \frac{1}{2}m(2 - \sqrt{2})$; the hypothenuse $= m(\sqrt{2} - 1)$.
15. $\frac{1}{33}(6 + \sqrt{3})2d$.
16. Hypothenuse = 39, and side = 36.
17. $\sqrt{m}(\sqrt{29} + 2)^{\frac{1}{2}}$.
18. $a = (d\sqrt{2} + d)^2 = 576$.
20. FG $= \frac{b}{\sqrt{2}}$, and perpendicular CE $= \frac{2a}{b\sqrt{2}}$.

EXERCISE 77.

5. $2\left(\frac{a^2 - ab + b^2}{a^2 - b^2}\right)$ or $\frac{2ab}{a^4 - b^4}$.
6. $\frac{2}{a + b}$.
7. $\frac{1}{(x + a).(x + b).(x + c)}$.
8. $\frac{1}{a^4 - x^4}$.
9. $1 + 3x + 4x^2 + 7x^3 + 11x^4$, etc.
10. $\frac{(a + b + b^2).(a - b)}{b(a^2 + b^2)}$.
11. $1 + x + 2x^2 + 2 \times 4x^3 + 2 \times 4^2x^4$, etc.
12. $\frac{8x + 5}{24x^3 + 46x^2 + 29x + 6}$.
13. $\frac{a^2 + 2ab - b^2}{a^2 + b^2}$.
14. $x - \frac{1}{x} + 1$.
15. $x - \frac{1}{2}y + 1$.
16. $2\frac{a}{b} + 3\frac{b}{a}$.
17 $5a - 4b$.
18. $\sqrt[4]{2x}$.
19. $a\sqrt{b}$
20. x^3.
21. $(a^2 - b^2)^{\frac{m+n}{mn}}$.
22. $x^2 + 6xz^{\frac{1}{2}} + 9z^{\frac{2}{3}} - 4y$.
23. $\frac{\sqrt[3]{x}}{\sqrt[3]{x} + \sqrt[3]{y}}$.
24. $\left(\frac{b^{\frac{1}{m}}}{a^{\frac{1}{n}}}\right)^{m}$.
25. $2x^2$.
26. G.C.M. $= 2x - 3a$; $\frac{2x - 3a}{4x^2 + 6ax + 9a^2}$
27. $\frac{a^2 - ab + b^2}{a^2 + ab + b^2}$ and $\left(\frac{a + b}{a - b}\right)^2$.
30. $n^3 + 1$; and $n^{\frac{3}{2}} - 1$.
32. $5a^2 + 5ab\sqrt{-1} + 6b^2$.
35. $2x^{\frac{3}{2}}$ and $2y\sqrt{x}$.
36. $(a^{12})^{\frac{1}{12}}$, $(a^6)^{\frac{1}{12}}$, $(a^4)^{\frac{1}{12}}$, and $(a^3)^{\frac{1}{12}}$; and $(x^6)^{\frac{1}{15}}$, $(y^5)^{\frac{1}{15}}$, and $(z^{10})^{\frac{1}{15}}$.
37. $\frac{b^2}{a^2}$ and $x^{\frac{2}{3}} + a^{\frac{1}{3}}x^{\frac{1}{3}} + a^{\frac{2}{3}}$.
38. $x + 1$.
39. $4x^{\frac{2}{3}} - x^{\frac{1}{3}}$.
41. $\frac{(11y^n + x^3)x^m}{a^m - 11x^ny^n}$.
42. $\frac{3}{2x^{m+n}} = \frac{3}{2}x^{-m-n}$.
43. $c^{-2}x^{-3}(xy)^{m+n}$.
44. $1 - 8x^{\frac{1}{2}m} + 28x^m - 56x^{\frac{3}{2}m} + 70x^{2m} - 56x^{\frac{5}{2}m} + 28x^{3m} - 8x^{\frac{7}{2}m} + x^{4m}$.
45. $\frac{m}{1} . \frac{m-1}{2} . \frac{m-2}{3} . \frac{m-3}{4} . \frac{m-4}{5} . \frac{m-5}{6} . \frac{m-6}{7} . \frac{m-7}{8} . \frac{m-8}{9} . \frac{m-9}{10} . x^{m-10}y^{10}$.
46. $\pm a^{\frac{1}{2}}b^{\frac{1}{4}}x^{\frac{1}{2}}$ and $-2x^{\frac{1}{3}}yz^{\frac{2}{3}}$.
47. $-\frac{x^2y^m}{v_n z^{\frac{1}{2}}}$.
48. $x^2 + 3x - 7$.
49. $(-32x^{15})^{\frac{1}{5}}$ and $(243^{\frac{1}{5}}x^{\frac{1}{5}}y^{m})^{\frac{1}{5}}$.
51. $64a^3c^6b^{-12} + 48a^3c^7db^{-9} + 15a^4c^8d^2b^{-6} + 4a^3c^9d^3b^{-3} + \frac{15}{16}a^2c^{10}d^4 + \frac{3}{16}ab^3c^{11}d^5 + \frac{1}{64}b^6c^{12}d^6$.
52. $24310a^9b^8 - 24310a^8b^9$.
53. $192192a^8b^4c^4d^8$.
54. $-161700a^{97}b^3$.
55. $d(d + 1)^{-1}$.
56. $\frac{1}{2}\sqrt{11}$.
57. 49.
58. $\sqrt[5]{15}$ or 1·718771.
59. 16.
60. $\frac{1}{3}a\sqrt{3}$.
61. $-\frac{1}{2}$.
62. $x = 64$, and $y = 14$.
63. $x = 9$, and $y = 4$.

64. $x = 82$, and $y = 10$.
65. $x = 6$, and $y = 5$.
66. $x = 66$, and $y = 24$.
67. $x = \frac{2a\sqrt{d}}{\sqrt{8a^2 + 8c^4}}$; $y = \frac{c\sqrt{d}}{\sqrt{8a^2 + 8c^4}}$.
68. $x = 5$, and $y = 4$.
69. $x = 2\frac{1}{2}$, and $y = 23$.
70. $x = 5$, and $y = 2$.
71. $x = 7$, and $y = 11$.
72. $x = 4$, and $y = 30$.
73. $x = 10$, and $y = 3$.
74. $x = 5$, and $y = 2$.
75. $x = 5$, and $y = 2$.
76. $x = 11$, $y = 7$, and $z = 1$.
77. $x = 90$, $y = 6$, and $z = 21$.
78. $x = 5$, $y = 2$, and $z = 8$.
79. $x = 5$, $y = 8$, and $z = 2$.
80. $x = 8$, $y = 4$, and $z = 5$.
81. $w = 2$, $x = \frac{1}{2}$, $y = 1$, and $z = 4$.
82. $v = 16$, $w = 9$, $x = 12$, $y = 3$, and $z = 8$.
83. $x = 2$ or $-2\cdot2$; $y = 3$ or $\sqrt{10\cdot08}$.
84. $x = (\sqrt{5\frac{1}{4}} + \frac{1}{2})^{\frac{1}{2}}$.
85. $x = 2$ or $\sqrt[3]{-6}$.
86. 4 and 2.
87. $x = 2$, and $y = 6$.
88. $x = 8$, and $z = 5$.
89. $x = \frac{1}{2}(\sqrt{5} + 5)$, and $z = \frac{1}{2}\sqrt{5}$.
90. $x = 5$, and $y = 4$.
91. $x = 6$, and $y = 4$.
92. $x = 2$, and $y = 5$.
93. $x = 7$, and $y = 8$.
94. $x = 4$, and $y = 2$.
95. $x = 4$, and $y = 7$.
96. $x = 5$, and $y = 3$.
97. 2315.
98. 2180.
99. 4 or -3.
100. 5.

EXERCISE 78.

1. 8.
2. $x = 2$, $y = 8$, $z = 32$.
3. 32.
4. £20.
5. 2 lb. and 8 lb.
6. A, £68; B, £85.
7. 44 and 33.
8. 8 years.
9. 450, 825, and 1575.
10. 200 cavalry, 600 artillery, and 1,800 foot soldiers.
11. 19 crowns and 32 florins.
12. 10.
13. 15 and 8.
14. £40.
15. Base = 6 ft., and height 2 ft.
16. $\frac{b^2 + bx + x^2}{b^2 - bx}$.
18. $\sqrt{5} + \sqrt{14}$ is the greater.
19. Both $= a : b$.
20. $-\frac{1}{2}$.
21. 6 and 8.
22. $161\frac{1}{2}$.
23. $-\frac{1}{2}$ and 0.
24. $52\frac{1}{2}$.
25. 8 or 31.
26. 40,200 yards, or 22 miles 1,480 yards.
27. $5\frac{1}{4}$, $5\frac{3}{8}$, $5\frac{1}{2}$, and $5\frac{5}{8}$.
28. 2, $2\frac{1}{2}$, 3, $3\frac{1}{2}$, etc., to 10.
29. $4\frac{1}{2}$.
30. 3, 7, and 11.
31. $-\frac{1}{17}$, and $60\frac{8}{9}$.
32. -63.
33. 2.
34. 2, ± 1, $\frac{1}{2}$, $\pm \frac{1}{2}$, etc.
35. ± 3, 4^{1}, $\pm 6^{2}$.
36. 132, 176, and 220 yards are the three sides; 6082·1376 square yards, area of inscribed circle; and 11,616 square yards = area of triangle.
37. Top inch, $\frac{1}{4}$ hour; the fourth from the top, $46\frac{4}{11}$ minutes.
38. $\frac{1}{8}$th of a diameter, or 905 miles.
39. $x = (1 \pm \sqrt{3}) \pm \sqrt{3 \pm 2\sqrt{3}}$.
40. $x = \frac{a + \sqrt{ab} + b}{a - \sqrt{ab} + b}$.
41. $x = \sqrt{\frac{1}{2}} + \frac{1}{2}\sqrt{5}$.
42. $x = 21, 16, 11$, etc.; $y = 2, 5, 8$, etc.
43. Three ways: 50, 38, or 17 sovereigns; 20, 40, or 60 guineas.
44. 36.
45. 45, 91, and 14, or 90, 42, and 18.
46. 8959
47. At 2s. 4d., 5 lb., 10, 15, etc., (+ 5); at 2s. 6d., 34, 28, 22, etc. (− 6); at 3s. 4d., 61, 62, 63, etc. (+ 1).
48. Side of square $= a\sqrt{\frac{1}{2}}$.
49. Side of inscribed triangle, $a\sqrt{3}$; side of circumscribing triangle, $2a\sqrt{3}$.
50. Length $= \frac{a}{\sqrt{2}}\left\{\sqrt{2} \pm 1\right\}$; breadth $= \frac{a}{\sqrt{2}}\left\{\sqrt{2} \pm 1\right\}$.
51. £450.
52. 9.
53. The horse either cost £17, and then A had £5, B £11, and C £13; or the horse cost £34, and A had £10, B £22, and C £26.
54. They spent at least £879, and then A had £319, B £459, C £543, D £599, and E £639, etc.
55. 3 and $\frac{1}{3}$.
56. On the 8th day, and if they continue their journey they will meet again on the 15th day.
57. 6s.
58. 440.
59. 10s. and £13 10s.
60. 159 and 234.
61. $\frac{b}{g} - (a + b)$. The unit of the weight the same as that in which a and b are given.
62. 8 and 1.
63. $\frac{a}{2}(\pm\sqrt{3} + 1)$ and $\frac{a}{2}(\pm\sqrt{3} + 1)$.
64. $R = -\frac{r}{2} + \sqrt{\frac{3v}{\pi H} - \frac{3r^2}{4}}$.
65. $v = \sqrt{2ge}$.
66. 1523 nuts, 10s. $6\frac{11}{12}$d. value, and gain $= \frac{11}{12}$ of 1d.
67. $y = 23$d. per lb.; $x = 20$s. per cwt.
68. 86 or 1241, or any term of the progression formed by the common difference, 1155.
69. 1st = 5, 31, 57, or any term of the progression increasing by 26; 2nd = 3, 20, 37, or any term of the progression increasing by 17.
70. 106, 80, and 54.

ITALIAN.—VII.

[*Continued from Vol. VI., p. 850.*]

THE PREPOSITION *PER.*

THIS preposition denotes—

1. The *passage through a place*, or, more generally speaking, a relation between two objects, one of which gets moving along, piercing, penetrating, etc., *through* another. For example:—

A Ró-ma si può an-dá-re per Fi-rén-ze, o per Lo-ré-to, one may go to Rome by way of Florence or Loretto.

Per di sót-to, per di só-pra, through under there, through above there.

2. The *cause, motive, means* by which any purpose is or can be effected, *instrumentality*. For example:—

É-gli tá-ce per ti-mó-re, per ver-gó-gna, he is silent out of fear, for shame.

Lo-go-rá-to per il lún-go ú-so, worn out by a long use.

3. A *purpose, end*, or *aim in view, object, tendency, endeavour, effort*. This is a most frequent and important use of *per*, which in this case exactly coincides with the English conjunctions *to, in order to, so as to*. For example:—

Stu-diá-re, lég-ge-re, tra-dúr-re per im-pa-rá-re, to study, to read, translate in order to learn.

4. An *ability* or *qualification to do a thing*, also in this case corresponding to the English conjunction *to*, or to suitable prepositions with present participles. For example:—

Él-la ha in-gé-gno ab-ba-stán-za per fár-lo mé-glio di lui, she has sufficient intellect to do it better than he.

És-se-re, stá-re per fa-re quál-che có-sa, to be about to do something.

Cór-re-re per un mí-glio, to run a mile.

An-dá-re per tér-ra, per má-re, to go by land, by sea.

Tán-to per gión-no, per mé-se, so much a day, a month.

Fá-re qual-che có-sa per or-di-ne del pa-dró-ne, to do something by order of the master.

Prén-de-re, te-nér ú-no per la má-no, per un brác-cio, to take, hold one by the hand, by one arm.

An important use of *per* is the following:—*Per quanto*, or merely *per* (along with the noun, adjective, verb, etc., immediately connected with it) in the course of the sentence followed by *che* (thus: *per . . . che*), signify *as much as, however, as, whatever*, etc. For example:—

Per pó-co ch'i-o bé-va, however little I may drink, *or*, little as I may drink.

Per bél-la ch'él-la sí-a, however beautiful she may be, *or*, beautiful as she may be.

É-gli ha per mó-glie ú-na Ro-má-na, he has married a Roman.

VOCABULARY.

Agghiaccia, freezes or curdles.
Bene, good, profit, advantage.
Cagione, cause, occasion, reason, motive (*per cagione di*, or *a cagione di*, on account of).
Campo, m., field.
Carità, charity, compassion, mercy (*per carità*, for God's sake).
Colui, he (*per lo consiglio di colui*, or *per lo colui consiglio*, by his advice).
Consiglio, counsel, advice.
Di dì e di notte, day and night.
Divenne rosso, he turned red, blushed, coloured.
Dovere, duty, obligation,
Egli vien, he comes.
Fu seppelito, he was buried.
Galantuomo, honest man.
Giorno, day (*giorno per giorno*, every day).
Io, I.
Io lo tenni, I took him.
Io parlo, I speak.
L' ha preso, he seized him.
Lo dico, I say so.
Lo fo, I do it.
Lo indusse, he induced him, prevailed on him.
Lui, him.
Mantello, cloak.
Me, me (*per me, te*, as far as I am, thou art, concerned; as to or as for me, thee; for my, thy, part).
Minaccia, f., threat, menace.
Molti, many.
Morieno, they died.
Morto, dead.
Non mi precipitate, do not hurry me.
Parere, opinion.
Piacere, pleasure.
Poco, little (*per poco*, almost, nearly, well nigh).
Posta, f., post (*per posta*, by post).
Riguardo, regard, consideration.
Sangue, blood.
Sarei, should be.
Sarei caduto, I should have made a fall (*per poco sarei caduto*, I had like to have fallen)
Soffre, he suffers.
Vantaggio, advantage, benefit, profit, good.
Vena, f., vein.
Venivano, came.
Venne, he came.
Vergogna, shame, bashfulness.
Via, way, road, street, route, means, manner (*per via di*, by means of).
Villa, f., villa, country seat.

EXERCISE 20.

Translate into English :—

1. Lo fô per pia-cé-re, e non per do-vé-re. 2. Í-o lo tén-ni per un ga-lant uô-mo. 3. Í-o pár-lo per vô-stro van-tág-gio. 4. Per ri-guár-do dell' a-mí-co. 5. Lo in-dús-so per ví-a di mi-nác-ce. 6. Sóf-fre per ca-gió-ne di lui. 7. Mól-ti da lui ve-ní-va-no per con-sí-glio. 8. É-gli viên ó-gni giór-no. 9. Lo dí-co per vô-stro bê-ne. 10. Í-o per me sa-rê-i di pa-ré-re. 11. Ah si-gnó-re! per ca-ri-tà non mi pre-ci-pi-tá-te. 12. Per le víl-le, per i cám-pi, per le ví-e e per le cá-se di dì-e di nôt-te mo-riê-no (Boccaccio). 13. Per pô-co sa-rê-i ca-dú-to 14. Per con-sí-glio di co-lú-i. 15. Fu sep-pel-li-to per môr-to.

VOCABULARY.

Ál-to, high, tall.
C'è, v'è, there is.
Cin-que, five.
Ci só-no, there are.
Con-tén-to, content, contented, pleased.
Dié-ci, ten.
Die-ci-nó-ve, nineteen.
Die-ci-ót-to, eighteen.
Die-ci-sét-te, seventeen.
Dif-fí-ci-le, difficult.
Dó-di-ci, twelve.
Dú-e, two.
Fá-ci-le, easy.
Gli ál-be-ri, the trees.
Gli a-mí-ci, the friends, m.
Gli spécchi, mirrors.
Gli uô-mi-ni, the human beings, men.
I buô-ni lí-bri, the good books.
I gió-va-ni sér-vi, the young men-servants.
I lí-bri, the books.
I nô-stri fra-tél-li, our brothers.
I pá-dri, the fathers.
I tê-mi, the themes, exercises, etc.
Il fió-re, the flower.
Il giór-no, the day.
Il gió-va-ne sér-vo, the young man-servant.
Il lí-bro, the book.
Il mé-se, the month.
Il pá-dre, the father.
Il tê-ma, the theme, exercise on a rule of grammar, subject, thesis.
La cá-sa, the house.
La cit-tà, the city, town.
La má-dre, the mother.
L'ál-be-ro, the tree.
L'a-mí-ca, the female friend.
L'a-mí-co, the friend, (m).
L'an no, the year.
La pen-na, the pen.
L'ar-má-dio, the press, clothes-press, cupboard.
La sé-dia, the chair, seat.
La set-ti-má-na, the week
Le a-mí-che, the female friends.
Le buô-ne pén-ne, the good pens.
Le ma-dri, the mothers.
Le nô-stre so-rél-le, our sisters.
Le pén-ne, the pens.
Lo spéc-chio, the looking-glass, mirror.
L'uô-mo, the human being, man.
Mal-con-tén-to, discontented, dissatisfied, displeased.
Nó-ve, nine.
O, od, or.
Ót-to, eight.
Quat-tór-di-ci, fourteen.
Quát-tro, four.
Quín-di-ci, fifteen.
Ra-gio-né-vo-le, reasonable, rational, sensible.
Sé-di-ci, sixteen.
Sé-i, six.
Sém-pre, always, continually, invariably, ever.
Sét-te, seven.
Só-no, are.
Só-no di, belong to, (i.e. are of).
Spés-so, often, frequently.
Tre, three.
Tré-di-ci, thirteen.
Ún-di-ci, eleven.
Ú-no, one.
Ú-ti-le, useful, profitable, lucrative.
Vén ti, twenty.
Vi-a (in multiplication), times, multiplied by.

EXERCISE 21.

Translate into English :—

1. I buô-ni pa-dri e le buô-ne má-dri. 2. Le cá-se di qué-sta cit-tà só-no al-tís-si-me e bel-lís-si-me. 3. Qué-sto pô-ve-ro è sêm-pre con-tên-to. 4. Le fí-glie di nô-stro zí-o só-no con-ten-tís-si-me. 5. La má-dre d'En-rí-co á-ma i fiô-ri ed i fan-ciúl-li. 6. Gli a-mí-ci di Gio-ván-ni só-no ar-ri-vá-ti. 7. Le a-mí-che di mí-a so-rêl-la só-no par-tí-te per Ró-ma. 8. Gli ál-be-ri nel nô-stro giar-dí-no só-no an-có-ra mól-to píc-co-li. 9. Qué-sti uô-mi-ni só-no sêm-pre mal-con-tên-ti. 10. I tê-mi di mí-o cu-gí-no só-no fá-ci-li; ma i tê-mi di mí-o fra-têl-lo só-no mól-to dif-fí-ci-li. 11. I vô-stri cu-gí-ni só-no ríc-chi, ma le vô-stre so-rêl-le só-no po-ve-rís-si-me. 12. Hai tu ve-dú-to gli ál-be-ri ed i fió-ri nel nô-stro giar-di-no?

EXERCISE 22.

Translate into Italian :—

1. The friends of my uncle are very rich. 2. I have often seen these men. 3. The children of our gardener's wife are reasonable. 4. We have found Henry's sisters in the church. 5. Your exercises are difficult, but the exercises of Lewis are very easy. 6. Have you received these beautiful flowers from John? 7. I have received from my uncle a pen-knife and twenty pens. 8. This lady has seven children. 9. This man has four sons and two daughters, who are very reasonable. 10. We have received five letters from our aunt. 11. My friend has found a pen-knife and eight pens. 12. Four multiplied by five *produce*[*] twenty.

THE PREPOSITIONS *SOPRA* (*SOVRA*), *SU*.

These prepositions generally denote the relation of two things or persons, one of which is on a higher locality than the other, or one of which surpasses the other with regard to some quality.

Examples :—

So-pra la tá-vo-la, só-pra la tér-ra, on the table, on the earth or ground.
Por la ma-no so-pra il pét-to, to lay the hand on one's breast.
Súl-la cí-ma di u-na er-ta mon-tá-gna, on the top of a steep mountain.

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[*] English words printed in italics in the Exercises must be left out in translating into Italian.

Ú-na cit-tà si-tuá-ta só-pra un fiú-me, sul Rê-no, súl-la ma-rí-na, a town situated on a river, on the Rhine, on the sea-coast.
An-dá-re só-pra i ne-mí-ci, to go against the enemy.
Pré-stá-re só-pra pé-gni, to lend on securities.
Pen-sá-re, dí-re, par-lá-re, dis-cór-re-re só-pra quál-che có-sa, to think, speak, talk, discourse of something.
L'a-má-va só-pra la ví-ta sú-a, he loved him more than his own life.

In su is frequently used in the place of *su*. For example:—

Sul tét-to, or *in sul tét-to*, on the roof.
Sul or *in sul mèz-zo dì, sul vè-spro, sul tra-mon-tar del só-le*, towards, about noon, or twelve o'clock, towards evening, at sunset.

Euphony sometimes requires the addition of the letter *r* to the particle *su*, especially before a word commencing with *a*.

In sur ú-na piáz-za, on a square

THE PREPOSITIONS *FRA, TRA, INFRA, INTRA.*

These prepositions generally correspond to the English prepositions *between, betwixt, among, within, in the course of, in.* For example:—

Tra il mú-ro ed il fiú-me, between the wall and the river.
Fra ti-mó-re e spe-rán-za, between fear and hope.
Tra pó-chi gior-ni, in a few days.

Before the personal pronouns *me, se*, etc., *fra* and *tra* have a peculiar meaning corresponding to the English prepositions *to, with*, and are used, as it were, in the places of *dén-tro me, dén-tro se*, within me, within himself. For example:—

Fra se me-dé-si-mo dis-se, he said to himself.
Tra me so-vén-te di-cén-do, frequently saying to myself.

VOCABULARY.

Aria, air, tune, song.
Assiso, seated, sitting.
Baule, trunk, chest.
Carrozza, carriage.
Ciò resti, that must remain.
Clavicembalo, harpsichord, pianoforte.
Cuore, heart.
Dà, gives (*i.e.*, is situated towards, faces, or fronts).
Di lui, of him, his.
Discordia, discord.
Disgrazia, misfortune.
Fare, to do, make, cause (*sul far* or *al far del giorno, in sul nascere del giorno*, at the break of day).
Fatto, fact, deed, act (*sul fatto*, in the act, in the very act).
Fede, faith.
Fiume, river.
Francoforte, Frankfort.
Genitore, father.
Ha pianto, he has shed tears.
Il più sfortunato, the most unfortunate.
Infelice, wretched, unhappy, unlucky.
Io diceva, I said.
Io sto, I stand, I am.
Labbro, m., lip (pl. *labbri*, m., or, better, *labbra*, f.).
Magonza, Mentz.
Marito, husband.
Meno, Maine (river).
Mezza notte, midnight.
Moglie, wife.
Monte, mountain.
Non ha diritto veruno, he has no right whatever.
Non lo so, ma lo saprò bene, I do not know, but I shall be sure to know it.
Non saprei risponderti, I should not be able to give you an answer.
Parola, word.
Poco, little (*tra poco fra poco*, in a little or short time, ere long).
Punto, point, subject.
Qualche, some.
Quello che, what.
Reno, Rhine.
Riccardo, Richard.
Riconoscenza, gratitude, acknowledgment.
Riposatevi, you may rely.
Sasso, stone, rock.
Scoglio, rock (in the sea, river, etc.), cliff, crag
Sempre, always.
Sera, evening (*sul* or *in sul far della sera, in sulla sera*, towards evening).
Si può parlare liberamente, one may speak unreservedly.
Sia detto, be it said (*ciò resti fra di noi, sia detto fra noi*, we must keep it a secret, or to ourselves).
Speranza, hope.
Stesso, self (*io diceva fra me stesso*, I said to myself).
Strada, street.
Tale, such.
Timore fear.
Tavolino, table.
Vi prometto, I promise you.
Voglio suonare, I wish to play.

EXERCISE 23.

Translate into English:—

1. Ma-gón-za, cit-tà sul Rê-no. 2. Fran-co-fôr-te, sul Mê-no. 3. Sul fát-to. 4. Vi pro-mêt-to súl-la mí-a fé-de. 5. Su qué-sta têr-ra. 6. Su quál-che ta-vo-lí-no. 7. Non sa-prê-i ri-spón-der-vi su tal pún-to. 8. I ba-ú-li só-no súl-la car-rôz-za. 9. Ha piàn-to súl-la di lui dis-grá-zia. 10. Non ha di-rít-to ve-rú-no súl-la mí-a ri-co-no-scên-za. 11. Ri-po-sá-te-vi súl-la mí-a pa-rô-la. 12. La cá-sa dà súl-la strá-da. 13. Sul far del giór-no (or *in sul ná-sce-re del giór-no*). 14. Sul far dél-la sé-ra (or *in súl-la sé-ra*). 15. Súl-la (or *in súl-la*) mêz-za nôt-te. 16. Fra a-mí-ci si può par-lá-re li-be-ra-mén-te. 17. Il più sfor-tu-ná-to fra' ge-ni-tó-ri. 18. Ciò rê-sti fra di noi; sí-a dét-to fra noi. 19. Í-o di-cé-va fra me. 20. É-gli ver-rà fra diê-ci giór-ni.

VOCABULARY.

A-da-cquá-to, watered, washed, bathed.
Al-lé-gro, cheerful, gay, merry, sprightly, jolly, jovial.
Creá-to, created, produced, caused.
Dí-o, God.
É-gli-no hán-no, they (m.) have.
Él-le-no hán-no, they (f.) have.
Fe-dé-le, faithful, loyal, trusty, true.
I miê-i fra-tél-li, my brothers.
I suó-i fra-tél-li, his (her, its) brothers.
I tuó-i fra-tél-li, thy brothers.
Il cá ne, the dog.
Il faz-zo-lét-to, the pocket-handkerchief.
Il gát-to, the cat.
Il lo-ro, theirs.
Il mí-o, mine.
Il món-do, the world.
Il nó-stro, ours.
Il po-mo, the apple.
Il prá-to, the meadow, pasture-field.
Il sú-o, his, hers, its.
Il toc-ca-la-pis, the lead-pencil.
Il tú-o, thine
Il vó-stro, yours.
La ci-riè-gia, the cherry
La nôt-te, the night.
La pé-ra, the pear.
La têr-ra, the earth, soil.
Man-dá-to, sent.
Pián-to, wept, shed tears, bewailed.
Trí-sto, sad, afflicted, melancholy.
Tut-ta la ca-sa, the whole house.
Tút-te le cá-se, all houses.
Tut-ti i fió-ri, all flowers.
Tút-ti gli uó-mi-ni, all men, everybody.
Tut-to, whole, entire, all, every.
Tút-to il món-do, the whole world, all the world.

EXERCISE 24.

Translate into Italian:—

1. My brothers are very melancholy. 2. Hast thou seen our glasses and our bottles? 3. Where are your pocket-handkerchiefs and ours? 4. I have given (to) this poor child my pens and thine. 5. My father has sold his dogs and mine. 6. Have you also sold yours? 7. Thy wife has bought ten glasses and four bottles for her daughter. 8. All these bottles belong to our uncle. 9. I love all these beautiful flowers. 10. I think every day (i.e., *all days*) of Charles. 11. I have seen the whole town. 12. Louisa has (i.e., *is*) departedwith all her (female) friends.

KEY TO EXERCISES.

Ex. 12.—1. He has returned from the wood. 2. He has already departed from Naples. 3. I am betrayed by you, by all. 4. He is descended from a noble family. 5. Far from my parents. 6. On whom do you depend? 7. One does not distinguish the one from the other. 8. He has not yet gone out of the city. 9. Everywhere. 10. From one side. 11. They did not want to go out through this place. 12. I have been to my sister.

13. After dinner I shall go to him. 14. He came this morning to me. 15. He lives (lodges, resides) at his father's (*or* in his father's house, *or* with his father).

Ex. 13.—1. Egli viene dalla cavallerizza e non dal giardino. 2. Da Amburgo a Parigi ci sono cento novanta miglia francesi. 3. Vien' egli dalla bottega? 4. Venite voi dalla commedia? 5. No, veniamo dal ballo. 6. I mobili del Signor Hall sono stati venduti da suoi eredi. 7. Donde vengono questi signori? 8. Alcuni ritornano dalla caccia, altri dal passeggio, e questi ultimi dalla pesca. 9. Ecco il danaro che mi è stato spedito dal padre. 10. Questo dipende dalla madre, e non dal fratello 11. Il passaggio dalla virtù al vizio è assai più corto che quello dal vizio alla virtù. 12. Io aspetto una riposta da Giovanni; egli è già stato tre mesi in Londra. 13. Guglielmo è ritornato oggi da Parigi.

Ex. 14.—1. She is in the next room. 2. I am almost in port. 3. He is in Austria, in Italy, in the country, spending the summer season. 4. He goes into the garden, into that room, to France, to the country, to Scotland, to Turkey. 5. He is in the yard, in the kitchen, in the cellar. 6. He has gone to church, to town, to the square, to the theatre. 7. He lived in that house. 8. I found him in bed. 9. Anthony is angry with me. 10. It is spoken of in the whole city. 11. He departed in haste. 12. He went there in a carriage. 13. They have gone out at this moment. 14. You are now in my hands. 15. I came before him on tiptoe, and here I wait till he comes. 16. I rely on my brother's ability. 17 Some copies will be printed on parchment. 18. You are in the bloom of youth, the prime of life.

Ex. 15.—1. Il giardino di mio zio è grandissimo. 2. Abbiamo veduto la tavola ed il letto di tuo padre. 3. Ho ricevuto questo mantello da mia zia. 4. Avete voi ricevuto un libro da questo fanciullo? 5. Abbiamo prestato il nostro ombrello a vostro fratello. 6. Avete voi trovato questa penna nella vostra scuola? 7. Abbiamo scritto una lettera a nostro zio ed a nostra zia. 8. Vostra madre ha dato una cuffia a mia sorella. 9. Avete voi veduto un bambino nel nostro giardino?

Ex. 16.—1. Gl'infelici trovano consolazione nella speranza. 2. Vostra sorella non è nella camera, ella sarà andata o nella cucina o nella cantina. 3. Vogliamo andare e far colazione nel casinetto? 4. In aggradevole compagnia il tempo passa assai presto. 5. Non c'e nessuno nel castello? 6. No, il castaldo è uscito in questo punto. 7. Voi avete avuto bel tempo nel vostro viaggio. 8. Voi avrete (ella avrà) in questo biglietto l'indirizzo del conte. 9. Egli nascose la chiave in quel l'armadio.

Ex. 17.—1. To look askance. 2. Please to come with me. 3. Carry the lantern with thee. 4. He took it with him. 5. In course of time. 6. He was killed with a pistol-shot. 7. With an alarmed countenance he told me. 8. On purpose, intentionally. 9. With astonishment. 10. Away with this thing. 11. With good grace. 12. With awkwardness. 13. With your kind permission. 14. Most magnificently. 15. With all the strength.

Ex. 18.—1. Il mio libro è sullo scanno. 2. Ho dato il mio cappello a questo povero fanciullo. 3. Il libro che ho ricevuto da un amico è perduto. 4. Avete voi trovato l'anello di Carlo? 5. Il giardino di Giovanni è piccolissimo. 6. L'amico di Guglielmo è partito. 7. Mio cugino è arrivato. 8. Abbiamo ricevuto una lettera da Luigi; egli è a Milano. 9. Ridolfo è partito per Venezia. 10. Avete voi veduto l'oriuolo di Luigi? 11. È vostro zio partito per Parigi? 12. La zia di Carlino è in Londra. 13. Il nostro vicino ha un figlio che si chiama Rodolfo ed un figlia che si chiama Luigia.

Ex. 19.—1. Il nipote è andato a pranzare nel parco col figlio e colla figlia del generale. 2. La settimana ventura vogliono andare tutti insieme in campagna. 3. Un corriere è arrivato colla nuova della pace. 4. Il cugino arrivò qui coll'ordine espresso di comprare un cavallo ed una carrozza. 5. Il mondo è pieno d'ingrati: si vive cogl'ingrati, si lavora pegl'ingrati e si ha da far sempre cogl'ingrati.

APPLIED MECHANICS.—VIII.

[*Continued from Vol. VI., p.* 346.]

LAWS OF SOLID AND FLUID FRICTION—EXPERIMENTAL DEDUCTIONS—WASTE OF ENERGY BY FRICTION—TRANSMISSION OF POWER BY BELTS.

HAVING considered some of the effects produced by friction, it may not be out of place to inquire what the quantitative laws are which the phenomena connected with friction appear to follow. The *relative* motion of two bodies, in contact and pressed together, or of particles of the same body, is resisted by a force or forces which we attribute to friction, though what friction itself really is we do not know. Whatever friction may be, some of its phenomena are well known to all, and have been the subject of experiment by Coulomb 100 years ago, and Morin and many others since. It is only necessary to refer briefly to these experiments. The apparatus employed by General Morin was somewhat like that shown in Fig. 43.

The loaded box or slider C was pulled steadily along the level surface A by a force W. It was found, as the weight of C increased, W had to be increased in the same proportion. It also appeared that within certain limits no change was produced in W by altering the area of the surface of C in contact with A, and further, that the *speed* of C did not seem to affect to any great extent the value of W required, if the weight of C remained the same.

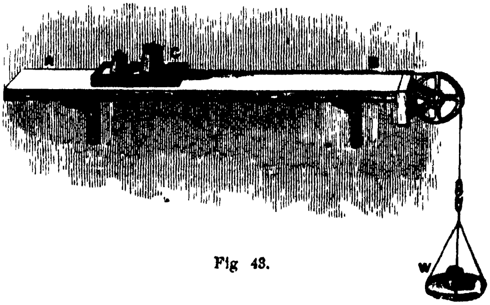

Fig 43.

The same laws are found to hold when the apparatus employed is like that shown in Fig. 44. The slider is placed on the plane AA, which can be tilted to different angles, gravity causing the weight to move steadily down the plane when a certain angle—called the "limiting angle of friction"—is reached. This, it is easy to show, is but another illustration of the first of the laws already mentioned, and the others can also be tested as before.

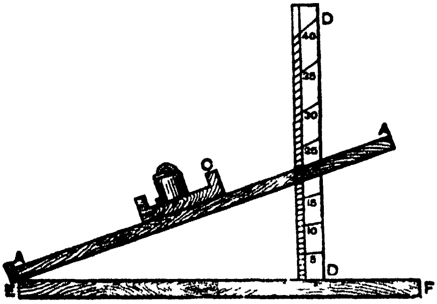

Fig. 44.

FRICTION OF FLUIDS.

This part of the subject is somewhat complex, at least from a mathematical point of view, but it will be sufficient if we state the results which have been arrived at mainly by experiment. The student may easily carry out an interesting experiment with a piece of apparatus such as that shown in Fig. 45, where a heavy disc, F, is suspended partially in a fluid contained in the vessel EE. If the disc is rotated friction causes the fluid also to rotate, the containing vessel trying to follow the fluid, the vessel being mounted on a vertical axis. If, now, this tendency of the vessel is counteracted by known forces, and the amount of these forces noted for different *speeds* of the disc, a very important law for the friction of fluids at different speeds is obtained. To find how the friction depends on pressure, an apparatus like that shown in Figs. 46 and 47 may be employed. Thus with a certain difference of level of the fluid in the two vessels, A and B, find how long it will take a given quantity of the fluid to run through the bent pipe when that pipe is held in different positions so that the pressure in it is different. If the given quantity of fluid always takes the *same time* to flow through under different pressures, we have some right to infer that friction in fluids does not depend on pressure. These and other experiments which we have not time to describe have resulted in the formulation of the following laws —

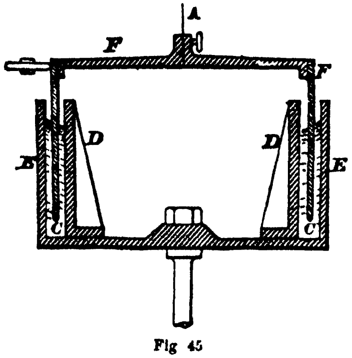

Fig 45

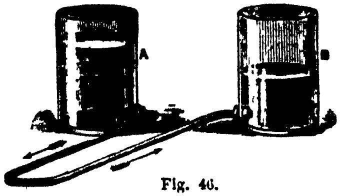

Fig. 46.

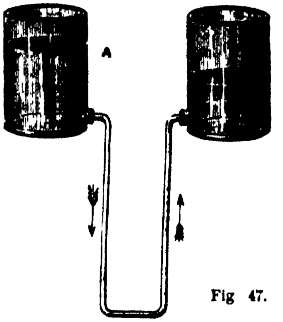

Fig 47.

Solids.	Fluids.
Friction is proportional to pressure	Friction is independent of pressure.
Friction is independent of area of contact.	Friction is proportional to wetted area.
Friction does not depend much on relative velocity.	Friction depends very much on velocity.

It is interesting to find such a complete contrast in the laws of solid and fluid friction. It should be noted, however, that the third law for solids cannot be tested with any degree of accuracy by any of the pieces of apparatus described. It may be tried more satisfactorily with the apparatus designed by Professor Perry and shown in Fig. 48. A piece of metal, or slider, rests on the convex surface of a pulley, which is driven either by hand or power. A sufficient force, due to the weight D, is applied to the slider to keep it always midway between two stops and on the highest part of the pulley. If the pulley is driven at different speeds, the suspended

load being kept constant, it is found that *different* forces are required to keep the slider in its proper position, thus showing that the third law is incorrect. The variation in friction is, however,

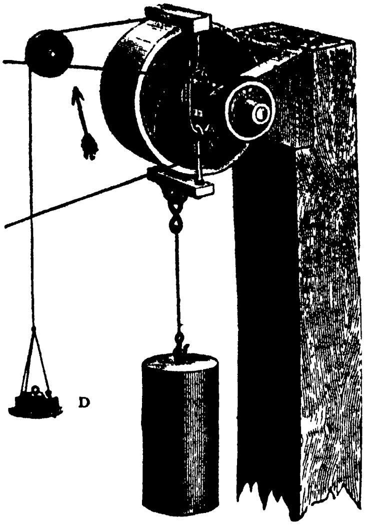

Fig. 48.

small for pretty wide changes of speed. The student can plot the actual law in the case of two given substances and within certain limits of speed. The other laws of solid friction may also be illustrated by this machine.

The first law of solid friction is generally written in the following concise form—

$$F = \mu P,$$

where F is the tangential force of friction, P the normal pressure between the two surfaces, and μ a coefficient called the *coefficient of friction*. It may be found by the apparatus shown in Fig. 44, and it can also be readily proved from the equilibrium of the forces, that the *tangent of the limiting angle of friction is equal to the coefficient of friction* for the same two surfaces.

The correctness of this rule will be seen by an experiment with the apparatus shown in Fig. 44. When the plane A A is elevated till the slider C just moves down with a steady speed, it will be found that the tangent of the angle which A A makes with the horizontal is equal to the coefficient of friction as found by the method indicated in Fig. 43.

Morin found some of the following mean values of this coefficient:—

Materials.	Coefficient of friction.
Oak on oak - - - - - - - - - -	·4
Wood on wood generally - - - - -	·25 to ·5
Wrought iron on oak - - - - - -	·6
Wrought iron on cast iron - - - -	·18
Cast iron on cast iron - - - - - -	·15
Leather on metals (dry) - - - - -	·3 to ·5

The student should remember that what we have called the "force of friction" is really the resultant of a great number of forces, just as the "force of gravity" is the resultant of all the forces of gravity acting on any body. Also, that friction is a *passive* force, always acting *against* motion. If, for instance, a man mounts a ladder, resting in the usual way against a wall, its foot tends to slip out, and friction acts *inwards* towards the wall; but if the man stands on the ground and pushes—or tries to push—the foot of the ladder towards the wall friction acts *outwards* against the intended motion.

Friction at bearing surfaces, such as the journals of shafts and axles, wastes energy by turning it into the less useful form of heat. The reduction of this waste is one of the great aims of the mechanical engineer, roller and ball bearings being used in many machines for this purpose. We should mention that the friction of two bodies *rolling together*, though much less, follows the same laws as for sliding contact, and Professor Osborne Reynolds

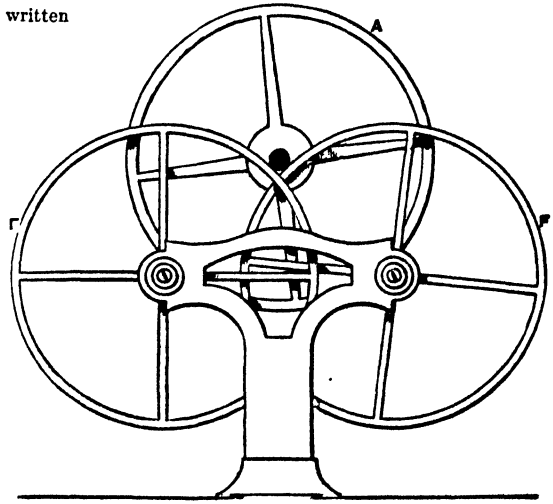

Fig. 49.

has shown that the friction in the former is really due to a sliding or creeping of the surfaces in contact, due to their deformation under the pressure.

Friction (or "anti-friction") wheels are sometimes used for machines in which the load is small, as, for instance, in Atwood's machine—referred to later on—where it is very important that the waste of energy by friction shall be as small as possible. The arrangement is shown in Fig. 49, where the axle of the wheel A, of which it is necessary to reduce the friction, rests on the rims of the two friction-wheels FF, instead of on bearings as usual. It will easily be seen that this arrangement diminishes *the distance of rubbing* per turn of A, for the rubbing now takes place at the axles of FF, which turn only through a small fraction of a revolution whilst A goes once round, whereas, if the friction-wheels were not used, rubbing would take place through a distance equal to the circumference of the axle A.

We have not space to refer to other ways of reducing friction, such as the use of lubricants and other methods familiar to the reader.

It must not be thought that friction is *always* undesirable; in fact, with the exception of gravity there is, perhaps, no phenomenon of nature to which we are more constantly indebted.

TRANSMISSION OF POWER BY BELTS.

One very familiar case in which we avail ourselves of the help of frictional resistances is that of transmitting power by means of a belt. The way in which a belt transmits power, and the fact that such a belt is subjected to *different* pulls on the two sides of the pulley it drives, or is driven by, will easily be understood by a simple illustration, such as that given in Fig. 50, where a pulley, A, fixed on a shaft, is turned by two unequal weights, N and M. That *both* weights are required is evident, showing us that there must be pulls in both sides of a belt which transmits power; and we also see that in order to turn the pulley they must be *unequal*.

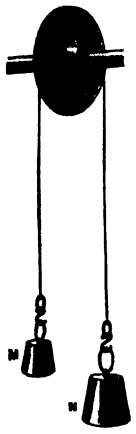

Fig. 50.

If the diameter of the pulley is d feet, then when it turns once round the weight N falls πd feet, and M rises an equal distance. The work done by N in falling is $\pi d N$ foot-pounds — if N is in pounds—and the work done on M is $\pi d M$ foot-pounds. The difference of these amounts is the work done on the shaft in one revolution, hence, if it has a steady speed of n revolutions per minute the work done per minute is $\pi d n (N - M)$ foot-pounds, and the horse-power transmitted by the belt is

$$\frac{\pi d n (N - M)}{33000}.$$

This is a very important rule, and should be carefully borne in mind.

In connection with the question of the friction between a belt and pulley a simple experiment may be made by fixing the pulley as shown in Fig. 51, and causing the belt to slip over it.

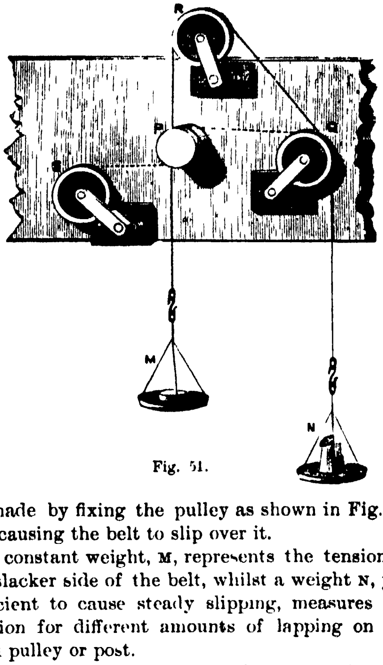

Fig. 51.

A constant weight, M, represents the tension in the slacker side of the belt, whilst a weight N, just sufficient to cause steady slipping, measures the friction for different amounts of lapping on the fixed pulley or post.

Such results as those given below are obtained in the experiment.

l, the lapping in terms of one circumference.	N, the weight just sufficient to overcome friction and the weight of M.	Logarithm of N.
½	80	1·9031
¾	105	2·0212
1	150	2·1761
1¼	200	2·3010
1½	265	2·4232
1¾	380	2·5797
2	501·2	2·7000

It will be seen that the figures in the first two columns follow a similar law to those given as an illustration of the compound interest law in lesson II., Vol. VI., page 35, the lapping increasing in *arithmetic* progression, whilst the friction increases in *geometric* progression. Such numbers when plotted give a logarithmic curve, and if columns 1 and 3 are plotted a straight line will be obtained, its law being

$$l = 1{\cdot}82 \log. \text{N} - 2{\cdot}91,$$
$$\text{or } l = 1{\cdot}82 (\log. \text{N} - 1{\cdot}6).$$

Now the constant weight M was 40, and log. 40 = 1·602, hence the law really is

$$l = 1{\cdot}82 (\log. \text{N} - \log. \text{M}),$$
$$\text{or } l = 1{\cdot}82 \log. \frac{\text{N}}{\text{M}}.$$

The law obtained mathematically is similar to this, being

$$\log. \frac{\text{N}}{\text{M}} = {\cdot}4343\, \mu\, \theta,$$

where θ is the angle in radians, embraced by the belt. The compound interest law already referred to is

$$\log. \frac{\text{A}}{\text{P}} = {\cdot}4343\, n\, r,$$

where A is the amount which the principal P becomes in n years, r being the interest of £1 for one year.

Combining our experimental law with the theoretic one, the value of the coefficient of friction μ, in our experiment, is easily deduced.

NUMERICAL EXAMPLES.

1 If the mathematical and experimental laws for the friction and lapping of a belt are correct, find, from the results obtained by the experiment referred to above, the coefficient of friction in that particular case. Answer, $\mu = \frac{1}{4}$ nearly

In the experiment the post was brass worn very smooth, and the cord had also been in use for some time. With leather on cast-iron, the usual substances in contact in the transmission of power by belting, the coefficient is much higher.

2 A machine is driven from a pulley 4 feet in diameter by means of a belt. If the difference of pull in the two sides of the belt is 20 pounds, and the pulley makes 150 revolutions per minute, find the power transmitted by the belt.

Answer, 1·41 horse-power.

3. The fly-wheel of a steam-engine is 9 feet in diameter, and makes 96 revolutions per minute What must be the difference of pull in the two sides of the belt if 26 horse-power is transmitted by it? Answer, 316 1 pounds

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ELOCUTION.—XII.

[Continued from Vol. VI., p. 360.]

PROMISCUOUS EXERCISES (*continued*).

XVII. THE DOWNFALL OF POLAND.

O sacred Truth! thy triumph ceased awhile,
And Hope, thy sister, ceased with thee to smile,
When leagued Oppression poured to Northern wars
Her whiskered pandours and her fierce hussars,
Waved her dread standard to the breeze of morn
Pealed her loud drum, and twanged her trumpet horn;
Tumultuous horror brooded o'er her van,
Presaging wrath to Poland,—and to man!

Warsaw's last champion from her height surveyed,
Wide o'er the fields a waste of ruin laid:
"O Heaven!" he cried, "my bleeding country save!
Is there no hand on high to shield the brave?
Yet, though destruction sweep these lovely plains,
Rise, fellow-men! our country yet remains!
By that dread name, we wave the sword on high!
And swear for her to live!—with her to die!"

He said, and on the rampart-heights arrayed
His trusty warriors, few, but undismayed;
Firm-paced and slow, a horrid front they form,
Still as the breeze but dreadful as the storm:
Low murmuring sounds along their banners fly,
"Revenge or death,"—the watchword and reply;
Then pealed the notes omnipotent to charm,
And the loud tocsin told their last alarm!

In vain, alas! in vain, ye gallant few,
From rank to rank your volleyed thunder flew:
Oh! bloodiest picture in the book of Time,
Sarmatia fell, unwept, without a crime;
Found not a generous friend, a pitying foe,
Strength in her arms, nor mercy in her woe;
Dropped from her nerveless grasp the shattered spear,
Closed her bright eye, and curbed her high career
Hope, for a season, bade the world farewell,
And Freedom shrieked—as Kosciusko fell.

The sun went down, nor ceased the carnage there;
Tumultuous murder shook the midnight air,—
On Prague's proud arch the fires of ruin glow,
His blood-dyed waters murmuring far below;
The storm prevails, the rampart yields away,
Bursts the wild cry of horror and dismay!
Hark! as the mouldering piles with thunder fall,
A thousand shrieks for hopeless mercy call!
Earth shook,—red meteors flashed along the sky,
And conscious nature shuddered at the cry!

O righteous Heaven! ere Freedom found a grave,
Why slept the sword, omnipotent to save?
Where was thine arm, O Vengeance! where thy rod,
That smote the foes of Sion and of God;
That crushed proud Ammon, when his iron car
Was yoked in wrath, and thundered from afar?
Where was the storm that slumbered till the host
Of blood-stained Pharaoh left their trembling coast;
Then bade the deep in wild commotion flow,
And heaved an ocean on their march below?

Departed spirits of the mighty dead!
Ye that at Marathon and Leuctra bled!
Friends of the world! restore your swords to man,
Fight in his sacred cause, and lead the van!
Yet for Sarmatia's tears of blood atone,
And make her arm as puissant as your own!
Oh! once again to freedom's cause return
The patriot Tell, the Bruce of Bannockburn!

Yes, thy proud lords, unpitied land! shall see
That man hath yet a soul, and dare be free!
A little while, along thy saddening plains,
The starless night of Desolation reigns;
Truth shall restore the light by Nature given,
And, like Prometheus, bring the fire of Heaven!
Prone to the dust Oppression shall be hurled,
Her name, her nature, withered from the world.

Thomas Campbell.

XVIII. EDMUND BURKE.

A sagacious critic has advanced the opinion, that the merit of Burke was almost wholly literary; but I confess I see little ground for this assertion, if literary excellence is here understood in any other sense than as an immediate result of the highest intellectual and moral endowments. Such compositions as the writings of Burke suppose, no doubt, the fine taste, the command of language, and the finished education, which are all supposed by every description of literary success. But in the present state of society, these qualities are far from being uncommon; and are possessed by thousands, who make no pretensions to the eminence of Burke, in the same degree in which they were by him. Such a writer as Cumberland, for example, who stands infinitely below Burke in the scale of intellect, may yet be regarded as his equal or superior in purely literary accomplishments taken in this exclusive sense.

The style of Burke is undoubtedly one of the most splendid forms in which the English language has ever been exhibited. It displays the happy and difficult union of all the richness and magnificence that good taste admits with a perfectly easy construction. In Burke we see the manly movement of a well-bred gentleman; in Johnson, an equally profound and vigorous thinker, the measured march of a grenadier. We forgive the great moralist his stiff and cumbrous phrases, in return for the rich stores of thought and poetry which they conceal; but we admire in Burke, as in a fine antique statue, the grace with which the large flowing robe adapts itself to the majestic dignity of the person.

But with all his literary excellence, the peculiar merits of this great man were, perhaps, the faculty of profound and philosophical thought, and the moral courage which led him to disregard personal inconvenience in the expression of his sentiment. Deep thought is the informing soul, that everywhere sustains and inspires the imposing grandeur of his eloquence. Even in the Essay on the Sublime and Beautiful, the only work of pure literature which he attempted—that is, the only one which was not an immediate expression of his views on public affairs—there is still the same richness of thought, the same basis of "divine philosophy," to support the harmonious superstructure of the language. And the moral courage which formed so remarkable a feature in his character contributed not less essentially to his literary success.

It seems to be a law of nature, that the highest degree of eloquence demands the union of the noblest qualities of character, as well as intellect. To think is the highest exercise of the mind; to say what you think, the boldest effort of moral courage: and both these things are required for a really powerful writer. Eloquence without thoughts is a mere parade of words; and no man can express with spirit and vigour any thoughts but his own. This was the secret of the eloquence of Rousseau, which is not without a certain analogy in its forms to that of Burke. The principal of the Jesuits' college one day inquired of him by what art he had been able to write so well. "*I said what I thought,*" replied the unceremonious Genevan; conveying in these few words the bitterest satire on the system of the Jesuits, and the best explanation of his own. —*A. H. Everett.*

In the "Downfall of Poland," by Thomas Campbell, and the spirited word-painting by Professor Wilson of the recovery of a child by its mother from an eagle's eyrie, to which even a sailor had not dared to climb, the reader will find admirable exercises, in the first-named for his elocutional powers, and in the latter for his ability to render a well-described scene even still more graphic by the manner in which he reads it.

The following is an extract from a debate for young speakers, and forms a useful exercise in elocution:—

XIX. CHARACTER OF JULIUS CÆSAR.

FIRST SPEAKER.—"Was Cæsar a great man?"—What revolution has taken place in the first appointed government of the universe—what new and opposite principle has begun to direct the operations of nature—what refutation of their long-established precepts has deprived Reason of her sceptre, and Virtue of her throne, that a character which forms the noblest theme that ever merit gave to fame, should now become a question for debate?

No painter of human excellence, if he would draw the features of that hero's character, need study a favourable light or striking attitude. In every posture it has majesty; and the lineaments of its beauty are prominent in every point of view.

It is a generally received opinion, that uncommon circumstances make uncommon men: Cæsar was an uncommon man in common circumstances. The colossal mind commands your admiration, no less in the pirates' captive, than in the victor at Pharsalia. Who but the first of his race could have made vassals of his savage masters, mocked them into reverence of a superior nature, and threatened, with security, the power that held him at its mercy? Of all the striking incidents in Cæsar's life, had history preserved for us but this single one, it would have been sufficient to make us fancy all the rest—at least, we should have said, "Such a man was born to conquest and to empire!"

To expatiate on Cæsar's powers of oratory would only be to add one poor eulogium to the testimony of the first historians. Cicero himself grants him the palm of almost pre-eminent merit; and seems at a loss for words to express his admiration of him. His voice was musical, his delivery energetic, his language chaste and rich, appropriate and peculiar. And it is well presumed that, had he studied the art of public speaking with as much industry as he studied the art of war, he would have been the first of orators. Quintilian says, he would have been the only man capable of combating Cicero; but granting them to have been equal in ability, what equal contest could the timid Cicero—whose nerves fail him, and whose tongue falters when the Forum glitters with arms—what equal contest could he have held with the man whose vigour chastised the Belgæ, and annihilated the Nervii, that maintained their ground till they were hewn to pieces on the spot?

His abilities as a master of composition were undoubtedly of the first order. How admirable is the structure of his Commentaries! What perspicuity and animation are there in the details! You fancy yourself upon the field of action! You follow the development of his plans with the liveliest curiosity! You look on with unwearied attention, as he fortifies his camp or invests his enemy, or crosses the impetuous torrent! You behold his legions, as they move forward from different points to the line of battle! You hear the shout of the onset, and the crash of the encounter; and, breathless with suspense, mark every fluctuation of the awful tide of war!

As a politician, how consummate was his address!—how grand his projections!—how happy the execution of his measures! He governs his province with such equity and wisdom as add a milder but a fairer lustre to his glory, and by their fame prepare the Roman people for his happy yoke. Upon the very eve of his rupture with Pompey, he sends back, on demand, the borrowed legions; covering with rewards the soldiers that may no longer serve him, and whose weapons on the morrow may be turned against his breast—presenting here a noble example of his respect of right and of that magnanimity which maintains that gratitude should not cease, though benefits are discontinued. When he reigns sole master of the Roman world, how temperate is his triumph!—how scrupulous his respect for the very forms of the laws! He discountenances the profligacy of the patricians, and endeavours to preserve the virtue of the State by laying wholesome restraints upon luxury. He encourages the arts and sciences, patronises genius and talent, respects religion and justice, and puts in practice every means that can contribute to the welfare, the happiness, and the stability of the empire.

It is unnecessary to recount the military exploits of Cæsar. Why should I compel your attention to follow him, for the hundredth time, through hostile myriads, yielding at every encounter to the force of his invincible arms? As a captain, he was the first of warriors; nor were his valour and skill more admirable than his abstinence and watchfulness, his disregard of ease and his endurance of labour, his moderation and his mercy. Perhaps, indeed, this last quality forms the most dominant feature in his character; and proves by the consequences of its excess, that virtue itself requires restraint, and has its proper bounds which it ought not to exceed—for Cæsar's moderation was his ruin!

That Cæsar had a heart susceptible of friendship, and alive to the finest touches of humanity, is unquestionable. Why does he attempt so often to avert the storm of civil war? Why does he pause so long upon the brink of the Rubicon? Why does he weep when he beholds the head of his unfortunate rival? Why does he delight in pardoning his enemies—even those very men that had deserted him?

It seems as if he lived the lover of mankind and fell—as the bard expresses it—vanquished, not so much by the weapons as by the ingratitude of his murderers.

If a combination of the most splendid talents for war with the most sacred love of peace—of the most illustrious public virtue with the most endearing private worth—of the most unyielding courage with the most accessible moderation, may constitute a great man, that title must be Cæsar's!

SECOND SPEAKER.—No change has taken place in the first appointed government of the universe; the operations of nature acknowledge now the same principle that they did in the beginning; Reason still holds her sceptre, Virtue still fills her throne; and the epithet of great does not belong to Cæsar!

I would lay it down, as an unquestionable position, that the worth of talents is to be estimated only by the use we make of them. If we employ them in the cause of virtue, their value is great; if we employ them in the cause of vice, they are less than worthless—they are pernicious and vile. Now let us examine Cæsar's talents by this principle, and we shall find, that neither as an orator nor as a politician—neither as a warrior nor as a friend—was Cæsar a great man!

If I were asked, "What was the first, the second, and the last principle of the virtuous mind?" I should reply, "It was the love of country." It was the love of parent, brother, friend!—the love of MAN!—the love of honour, virtue, and religion!—the love of every good and virtuous deed! I say, then, if I were asked, "What was the first, the second, and the last principle of the virtuous mind?" I should reply, "It was the love of country!" Without it man is the basest of his kind!—a selfish, cunning, narrow speculator!—a trader in the dearest interests of his species!—reckless of every tie of nature, sentiment, affection! What was Cæsar's oratory?—How far did it prove him to be actuated by the love of country? It justified for political interest the invader of his honour!—sheltered the incendiary!—abetted treason!—flattered the people into their own undoing!—assailed the liberties of his country, and bawled into silence every virtuous patriot that struggled to uphold them! He would have been a greater orator than Cicero! I question the assertion—I deny that it is correct!—He would have been a greater orator than Cicero! Well!—let it pass—he might have been a greater orator, but he could never have been so great a man. Which way soever he directed his talents, the same inordinate ambition would have led to the same results; and had he devoted himself to the study of oratory, his tongue had produced the same effects as his sword, and equally desolated the human kingdom.

But Cæsar is to be admired as a politician! I do not pretend to define the speaker's idea of a politician; but I shall attempt to put you in possession of mine. By a politician, I understand a man who studies the laws of prudence and of justice as they are applicable to the wise and happy government of a people, and the reciprocal obligations of states. Now, how far was Cæsar to be admired as a politician? He makes war upon the innocent Spaniards, that his military talents may not suffer from inaction. This was a ready way to preserve the peace of his province, and to secure its loyalty and affection! That he may be recorded as the first Roman that had ever crossed the Rhine in a hostile manner, he invades the unoffending Germans, lays waste their territories with fire, and plunders and sacks their country. Here was a noble policy!—that planted in the minds of a brave and formidable people the fatal seeds of that revenge and hatred which finally assisted in accomplishing the destruction of the Roman Empire! In short, Cæsar's views were not of that enlarged nature which could entitle him to the name of a great politician; for he studied not the happiness and interest of a community, but merely his own advancement, which he accomplished—by violating the laws and destroying the liberties of his country.

That Cæsar was a great conqueror I do not care to dispute. His admirers are welcome to all the advantages that result from such a position. I will not subtract one victim from the hosts that perished for his fame; or abate, by a single groan, the sufferings of his vanquished enemies. But I will avow it to be my opinion, that the character of a great conqueror does not necessarily constitute that of a great man; nor can the recital of Cæsar's victories produce any other impression upon my mind than what proceeds from the contemplation of those convulsions of the earth, which in a moment inundate with ruin the plains of fertility and the abodes of peace; or, at one shock, convert whole cities into the graves of their living population!

But Cæsar's munificence, his clemency, his moderation, and his affectionate nature, constitute him a great man! What was his munificence, his clemency, or his moderation?—the automaton of his ambition! It knew no aspiration from the Deity! It was a thing from the hands of the mechanician!—an ingenious mockery of nature! Its action seemed spontaneous—its look argued a soul—but all the virtue lay in the finger of the operator. *He* could possess no real munificence, moderation, or clemency, who ever expected his gifts to be doubled by return—who never abstained, but with a view to excess; nor spared, but for the indulgence of rapacity.—*Knowles.*

The following tract on the mission and duty of the man of learning affords a fitting conclusion to our lessons in Elocution:—

XX. THE SCHOLAR'S MISSION.

The wants of our time and country, the constitution of our modern society, our whole position—personal and relative—forbid a life of mere scholarship or literary pursuits to the great majority of those who go out from our colleges. However it may have been in other times and other lands, here and now, but few of our educated men are privileged—

> "From the loopholes of retreat
> To look upon the world, to hear the sound
> Of the great Babel, and not feel its stir."

Society has work for us, and we must forth to do it Full early and hastily we must gird on the manly gown, gather up the loose leaves and scanty fragments of our youthful lore, and go out among men, to act with them and for them. It is a practical age; and our Wisdom, such as it is, "must strive and cry, and utter her voice in the streets, standing in the places of the paths, crying in the chief place of concourse, at the entry of the city, and the coming in at the doors."

This state of things, though not suited to the tastes and qualities of all, is not, on the whole, to be regretted by educated men as such. It is not in literary production only, or chiefly, that educated mind finds fit expression, and fulfils its mission in honour and beneficence. In the great theatre of the world's affairs, there is a worthy and a sufficient sphere. Society needs the well-trained, enlarged, and cultivated intellect of the scholar in its midst!– needs it, and welcomes it, and gives it a place; or, by its own capacity, it will take a place of honour, influence, and power. The youthful scholar has no occasion to deplore the fate that is soon to tear him from his studies, and cast him into the swelling tide of life and action. None of his disciplinary and enriching culture will be lost or useless, even there. Every hour of study, every truth he has reached, and the toilsome process by which he reached it; the heightened grace or vigour of thought or speech he has acquired—all shall tell fully, nobly, if he will give heed to the conditions. And one condition, the prime one, is, that he be a true man, and recognise the obligation of a man, and go forth with heart and will, and every gift and acquirement dedicated, lovingly and resolutely, to the true and the right. These are the terms; and apart from these there is no success, no influence to be had which an ingenuous mind can desire, or which a sound and far-seeing mind would dare to seek.

Indeed, it is not an easy thing, nay, it is not a possible thing to obtain a substantial success, and an abiding influence, except on these terms. A factitious popularity, a transient notoriety, or, in the case of shining talents, the doom of a damning *fame*, may fall to bad men. But an honoured name, enduring influence, a sun brightening on through its circuit, more and more, even to its serene setting—this boon of a true success goes never to intellectual qualities alone It gravitates slowly but surely to weight of character, to intellectual ability rooted in principle.—*George Putnam.*

ACOUSTICS.—III.

[Continued from Vol. VI., p. 357.]

FACTS CONNECTED WITH THE PROPAGATION OF SOUND—VELOCITY OF SOUND IN DIFFERENT MEDIA — EFFECT OF CHANGE OF TEMPERATURE—RESONANCE—REFLECTION OF SOUND—ECHO.

It appears that sound can be propagated to some extent through almost all kinds of substances; indeed if a medium is not utterly destitute of elasticity, it will convey the vibrations of sound. Of course, in different media, sound is propagated at very different velocities and to different distances. It has been found that the velocity of sound in any medium *varies as the square root of its "elasticity"* and *inversely as the square root of its density*. If v represent the velocity, then it is obtained by the following rule:—

$$v = \sqrt{\frac{E}{D}},$$

where E is a coefficient generally called "Young's modulus" of elasticity, and D denotes the density of the medium. Solids can be subjected to different kinds of strain, whilst liquids and gases can be subjected to only one, hence we find different rates of propagation in solids, especially in different directions, but in liquids and gases only one rate of propagation in all directions.

The *temperature* of the medium, especially if gas or air, exercises a great effect on the rate of propagation of sound, whereas in solids the effect is comparatively small. The correction for changes of temperature will be referred to presently.

PROPAGATION OF SOUND BY SOLIDS.

The earth propagates sound readily, and travellers tell us that earthquake shocks have been heard at great distances, the sound having evidently been propagated through the earth rather than through the air. The North American Indians and other

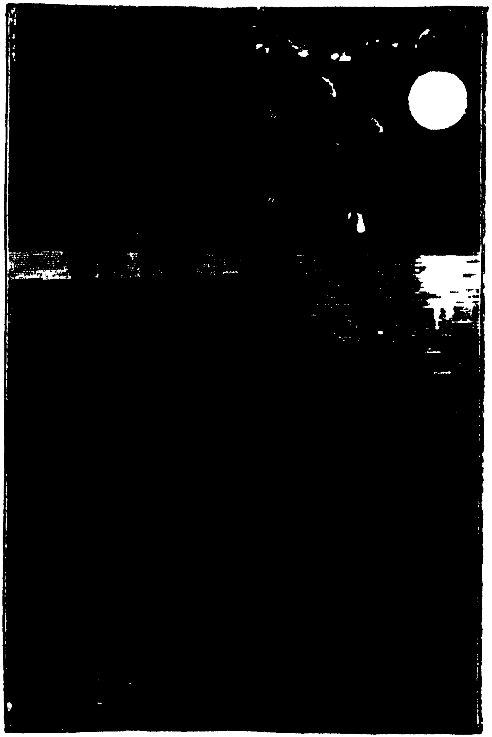

Fig 26.

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Solid	Rate of propagation of sound in feet per second.
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ron and Steel - - - - - - - -	16,500
opper - - - - - - - - - -	12,168
lass - - - - - - - - - - -	17,836
ak - - - - - - - - - - -	11,280
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The rule $v = \sqrt{\frac{E}{D}}$ gives the velocity of sound n gases. For example, hydrogen is, bulk for bulk, bout $\frac{1}{16}$ of the weight of air, and conveys sound bout four times as fast, a result in accordance with he formula. If the gas or air is heated in a close essel without being able to expand, it transmits ound more rapidly, its pressure being increased; and even in the free air a correction for rise of temperature is necessary.

Generally, if P denote the intensity of pressure of the air or gas, the velocity v given by the formula $v = \sqrt{\frac{E}{D}}$ will in practice lie between $v = \sqrt{\frac{P}{D}}$ and $v = \sqrt{1{\cdot}41\,\frac{P}{D}}$, and is generally found to agree nearly with the latter formula. It will be seen that the velocity of sound is independent of the height of the barometer, since any change of barometric pressure affects P and D alike. The result of change of temperature may be concisely, and with a fair amount of accuracy, put in the following form :— If the velocity of sound in air at 0° Centigrade is 1,087 feet per second, the velocity at t° Centigrade will be

$$1087\sqrt{1 + \frac{t}{273}}$$

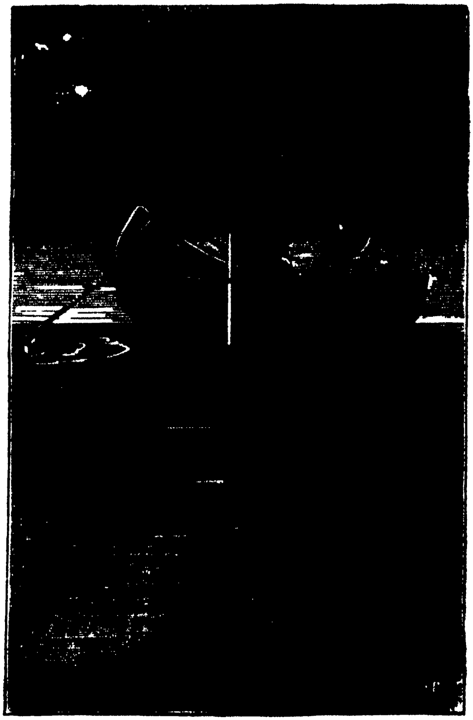

Fig. 27.

Many experiments have been made to determine the rate at which sound travels through the air, and we are able to calculate approximately, from the results obtained, the length of the waves produced

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[*Continued from Vol. VI., p. 357.*]

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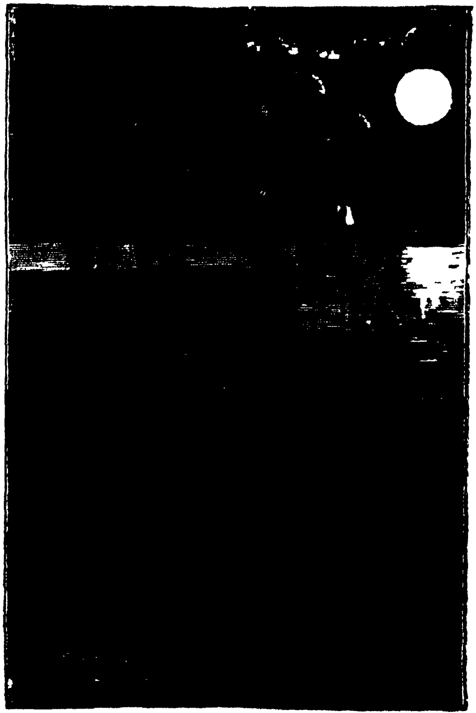

Fig 26.

hunters make use of this property of the earth, and place the ear to the earth when wishing to detect the approach of an enemy.

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The velocity with which sound is propagated in some solids has been found to be approximately as follows:—

Solid.	Rate of propagation of sound in feet per second.
Silver	8,803
Iron and Steel	16,500
Copper	12,168
Glass	17,836
Oak	11,280
Fir	19,660

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The rule $v = \sqrt{\frac{E}{D}}$ gives the velocity of sound in gases. For example, hydrogen is, bulk for bulk, about $\frac{1}{16}$ of the weight of air, and conveys sound about four times as fast, a result in accordance with the formula. If the gas or air is heated in a close vessel without being able to expand, it transmits sound more rapidly, its pressure being increased; and even in the free air a correction for rise of temperature is necessary.

Generally, if P denote the intensity of pressure of the air or gas, the velocity v given by the formula $v = \sqrt{\frac{E}{D}}$ will in practice lie between $v = \sqrt{\frac{P}{D}}$ and $v = \sqrt{1{\cdot}41\ \frac{P}{D}}$, and is generally found to agree nearly with the latter formula. It will be seen that the velocity of sound is independent of the height of the barometer, since any change of barometric pressure affects P and D alike. The result of change of temperature may be concisely, and with a fair amount of accuracy, put in the following form:— If the velocity of sound in air at 0° Centigrade is 1,087 feet per second, the velocity at t° Centigrade will be

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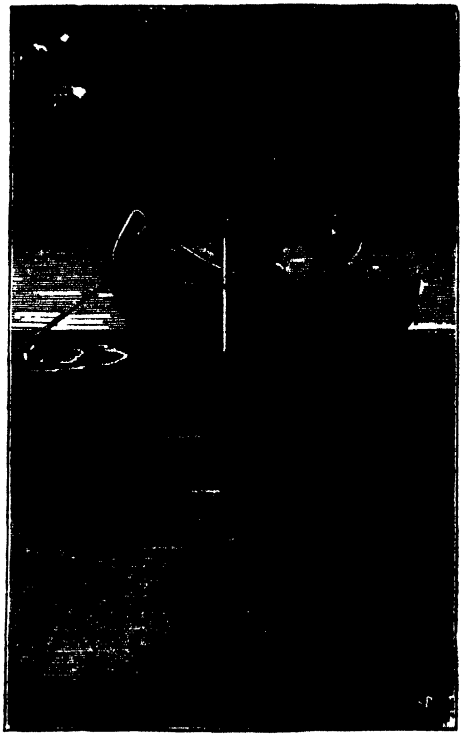

Fig. 27.

Many experiments have been made to determine the rate at which sound travels through the air, and we are able to calculate approximately, from the results obtained, the length of the waves produced by any given note. This inquiry is rather a difficult one, as there are many disturbing causes, such as the temperature of the air, the amount of watery vapour present in it, etc. A calm night is usually selected for the experiment, as the air is then much quieter. Two stations of observation are chosen, several miles apart, but so situated that each can be seen from the other. Cannons or guns are then discharged at regular intervals of about ten minutes, and, since the passage of light is practically instantaneous, the moment of firing is thus seen, and the distant observers note very accurately, by means of chronometers, the interval between seeing the flash and hearing the report. The true distance between the two stations is then measured, and, dividing this by the number of seconds, the velocity of the sound is ascertained. In an experiment of this nature tried in France many years ago, the distance between the observers was 20,354 yards, and, as the mean of several observations, the time occupied by the sound in travelling this distance was found to be 54·6 seconds. This gives a velocity of 1,118 feet per second, when the air is at 60° Fahr., that being the temperature during the experiment. The velocity and direction of the wind will of course affect the result. As the temperature increases, the speed increases likewise at about the rate of a foot a second for every degree. Generally, then, we may state the velocity of sound in the air at 60°Fahr. to be 1,120 feet a second, and to increase one foot per second for every degree Fahrenheit that the temperature is raised. More accurately the rate is increased two feet per second for every degree *Centigrade* rise of temperature, or 1·14 feet for one degree Fahrenheit. In other gases the velocity of sound is somewhat different: we can, however, easily determine it, since it is found to vary inversely as the square roots of their densities. Hydrogen, for example, is sixteen times less dense than oxygen, and sound travels through it at four times the speed. An increase of density thus serves to diminish the velocity, and this is why sound travels more slowly in air at a low temperature.

The following results are approximately those obtained by the experiments of Wertheim:—

Medium.	Rate of propagation in feet per second at the freezing temperature.
Air	1,085
Oxygen	1,040
Hydrogen	4,165
Carbonic Oxide	1,105
Carbonic Acid	859
Olefiant Gas	1,030

VELOCITY OF SOUND IN LIQUIDS.

The velocity of sound in water was measured by Colladon at the Lake of Geneva in 1826, and his "classical" experiments are worthy of description. Two boats were moored at a distance of 13,500 metres apart. One of them carried a bell immersed in the water, as shown in Fig. 26. Its hammer was moved by a lever which was so arranged as to ignite a small quantity of gunpowder at the same instant as the bell was struck; an observer in the other boat applying his ear to the trumpet-shaped tube as shown in Fig. 27, this tube having its lower end covered by a thin membrane and facing towards the bell. By noting the interval of time which elapsed between seeing the flash and hearing the sound, the velocity with which the sound travelled in water was determined. It should be observed that in all determinations like this, in which the senses of sight and hearing are both employed, an error may be introduced if impressions are received at different speeds by the two senses. It seems advisable to have observations of this kind checked by a second and independent observer.

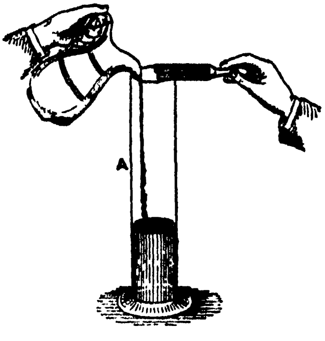

Fig. 28.

It has thus been found that in water the sound-waves are propagated at a rate of about 4,700 feet a second, solids (as already observed) conveying sound much more rapidly. A good illustration of the different rates at which gases and solids conduct sound may be observed by standing near a long iron railing, and getting a friend at a distance to strike it a violent blow. Two distinct sounds will be perceived, the first caused by the vibrations conducted along the railing, while the other has travelled through the air, and hence arrives considerably after the first. In blasting operations, two concussions are often heard from a similar cause, the one being conveyed by the solid rock, and the other transmitted through the air.

In substances which exhibit a fibrous or crystalline structure, the sound travels in different directions at different speeds. Along wood, for instance, it is conveyed in the direction of the fibres nearly four times as rapidly as across them.

Having now ascertained the velocity at which sound travels, we can easily determine the length of the sonorous waves. It is, however, important for us first of all to obtain a clear idea of their nature. In water, each wave consists of an elevation and a corresponding depression, and the length is measured from crest to crest. In sound-waves, we have in place of these an area of condensation and one of rarefaction, and the length is measured from one centre of compression to the next.

Now sound, as we have seen, travels 1,120 feet a second in air at the temperature of 60°, and a C tuning-fork—that is, one sounding the note an octave above middle C—produces, say, 512 vibrations in the same time. Dividing 1,120 by this, we find the length of the waves produced by that note to be about 2 feet 2 inches. An octave lower, the waves are about double the length, or about 4 feet 4 inches.

RESONANCE.

The above calculation may easily be verified by the student in rather a remarkable way, and in doing so he will obtain a good illustration of the manner in which a sound may be increased by resonance.

Take a tall glass jar, A, Fig. 28, and having struck a tuning-fork, hold it over the mouth of the jar. The sound will probably be unaffected. Now gently pour in water from a jug, making as little splash as possible; when it attains a certain height, the sound will be found to burst suddenly forth with greatly increased power. On pouring more water in, the sound sinks again to its former intensity. Ascertain, by repeating the experiment, the exact point at which the maximum intensity is attained, and then measure its depth from the top of the jar. If we are using a C fork, we shall find this depth to be 6½ inches, or just one-fourth the length of the wave. The return wave, therefore, is exactly synchronous with the return vibrations of the fork, and thus the sound is greatly increased and swells out with augmented intensity. When the water is at a different level, the vibrations interfere with one another, and clash to a certain extent.

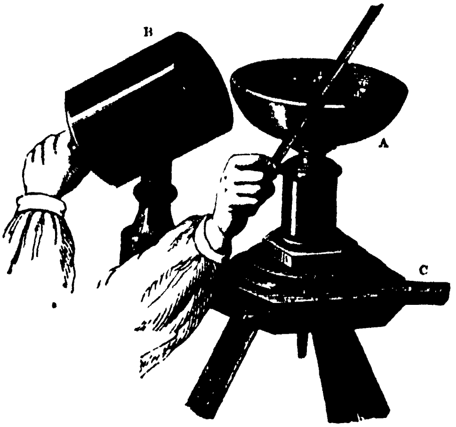

Fig. 29.

The manner in which the power of any sound is increased by resonance is well shown by an apparatus devised by Savart, and shown in Fig. 29. A large open-mouthed bell, A, is set in vibration by drawing a violin-bow across its edge. Close to it is a hollow cylinder, B, the length of which can be adjusted by means of a sliding tube. This cylinder is mounted on a universal joint, so that it can be turned in any direction, and its distance from A can be adjusted by means of the slide C, on which it is carried. The intensity of the sound will now be found to be greatly affected by the position of B. When the vibrations have almost ceased, so that the bell is nearly inaudible, the sound will at once swell out on properly placing the cylinder. The air contained in B is made to vibrate in unison with the bell, and hence the greatly increased power of the sound.

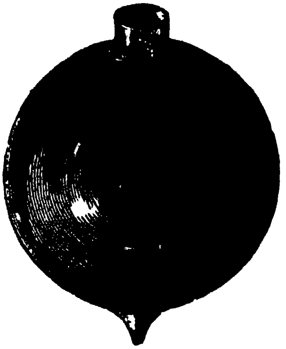

Fig 30.

It is stated that in ancient times large metal vessels were placed in theatres upon the stage in order to increase, by their resonance, the power of the actors' voices. In the present day care is taken in the construction of large buildings, to give them such a form as to render the speaker's voice audible with the least effort to himself.

RESONATORS AND ANALYSIS OF TONES.

Helmholtz employed, in his researches on musical tones, a hollow globe of thin brass, called a resonator (Fig. 30), open at both ends, the larger opening admitting the sound and the smaller being applied to the ear. In a similar way to that already described the resonator "speaks" in response to a note which is the same as the fundamental tone or note of the enclosed column of air. These instruments were constructed to form a series corresponding to the bass C of a man's voice and its

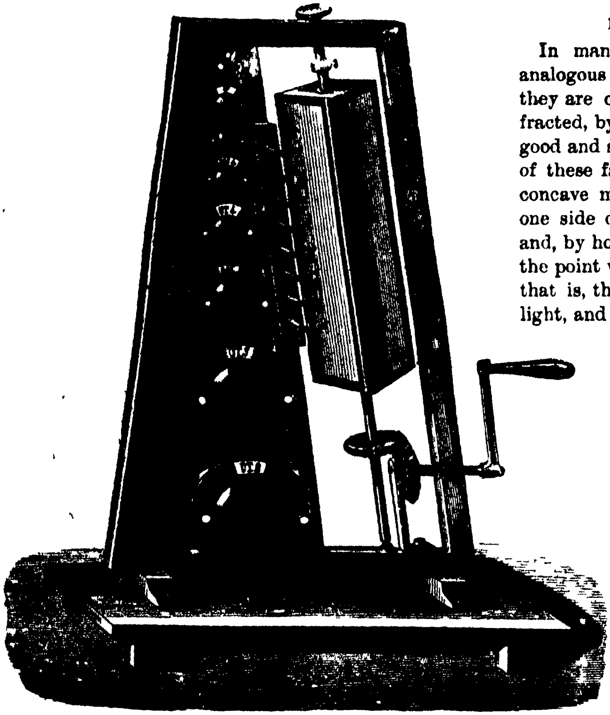

Fig 31.

successive upper harmonics. In order to test for the presence of a particular harmonic in a given musical note, a resonator, in unison with the harmonic, is applied to the ear and held in a proper position with regard to the source of the musical

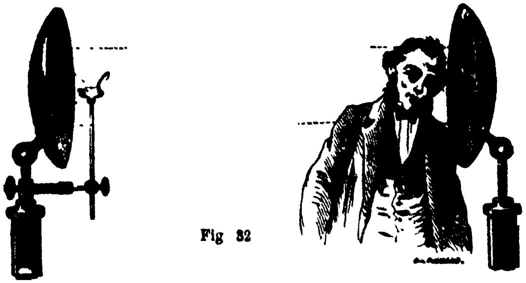

Fig 32

tone. If the resonator "speaks," the harmonic is present. Koenig applied his manometric flames to a series of resonators, as shown in Fig. 31, and a revolving mirror at once showed to many spectators which of the resonators responded to a sonorous body passed in front of them.

REFLECTION OF SOUND, ECHO.

In many respects waves of sound are closely analogous to rays of light and heat; like them they are capable of being reflected, and even refracted, by the employment of suitable lenses. A good and simple experiment to illustrate the former of these facts can easily be tried with an ordinary concave mirror. Having placed a bright light at one side of the room, place the mirror opposite it, and, by holding some object in front of it, ascertain the point where the image of the light is formed—that is, the focus of the mirror. Now remove the light, and in its place suspend a watch. Owing to the distance, its sound will probably be inaudible to a person standing near the mirror ; but let him place his ear at the focus, and he will at once distinctly hear it. As it is somewhat difficult to find the exact focus for the ear, the experiment will succeed better if a funnel be held at the focus, and the ear applied to the tube of this. The sonorous waves will thus be more fully collected and conveyed to the ear. The funnel in this case fulfils a similar purpose to a hearing-trumpet, the waves being reflected from side to side till they travel down the tube.

If two concave mirrors be employed, as shown in Fig. 32, instead of one, the watch being placed in the focus of the one, and the funnel at that of the other, the sound will be heard at a much greater distance. Curved roofs and ceilings sometimes act in this way, and reflect the sound, and hence the ceilings of large buildings have usually a vaulted form The arch of a bridge acts similarly, and two persons, properly placed under it, may often hold conversation with one another in tones so low that they are totally inaudible to a third individual standing between them.

In a similar way, two people situated in the foci of large concave mirrors may hold conversation with one another at a great distance. Two such mirrors, about six feet in diameter and about one hundred feet apart, were some time ago at opposite ends of the large hall in the Polytechnic Institution at London. It was found that even when the hall was filled with people, and there was much noise, whispers uttered by those in the focus of one could be heard by a listener in the focus of the other.

The well-known whispering-gallery of St. Paul's is another good illustration of the reflection of sound. The wall surrounding the gallery is circular and smooth, and hence the vibrations produced by the voice, instead of being dissipated in space, are reflected from spot to spot, till they reach the ear of the listener at the opposite side.

Fig. 33 will explain the manner in which the waves of sound are thus reflected by any smooth surface against which they strike. If the surface be rough or uneven, they will of course be irregularly broken up and scattered, just as the rays of light which fall upon an uneven surface are irregularly diffused.

If A be the position of a sounding body, the waves of sound produced by it will be represented by concentric circles so long as nothing intervenes to interfere with their motion. They soon, however, reach the obstacle P Q, where their course is arrested. The sound first meets this obstacle on the line A *a*, and is thrown back, so that the wave, M C D N, has its middle portion deflected into the arc C K D. The wave which reaches any point, C, will have travelled in the direction A C; but since the angle of incidence is equal to that of reflection, it will continue its course in the direction C B, and, to an observer at B, will appear to have proceeded from the point *a*, situated as far behind P Q as A is in front of it By considering in a similar way the waves that meet each portion of the obstacle, we shall find that the curve, C K D, in which the wave continues to move, after being reflected, is in reality an arc of a circle, whose centre is at the point *a*. The laws of the reflection of sound are thus exactly the same as those for the reflection of light, and need not, therefore, be further explained.

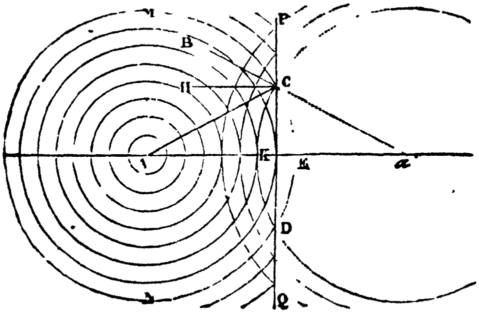

Fig. 33.

An *echo* is a repetition of a sound caused by the waves being reflected to the ear from some obstacle, as, for instance, a cliff or a lofty wall. If the reflecting surface be very near, a distinct echo will not be produced, as the sound will return so quickly as to mingle with the original one, and merely render it somewhat indistinct; in fact, at distances of less than 100 feet from the surface there is not time for the reflection of a distinct syllable. This effect is well seen in speaking in a large empty room (Fig. 34), where the reflection from the walls will frequently render the words almost unintelligible. When the room is filled, the sound-waves are so confused and absorbed that this effect is much lessened. Curtains are frequently suspended in large rooms for the purpose of further damping the echo.

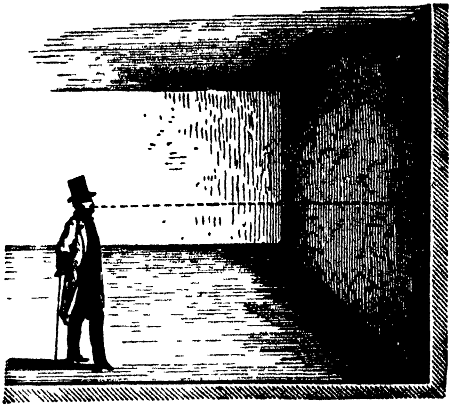

Fig 34.

SPANISH.—III.

[Continued from Vol. VI., p. 365.]

POSSESSIVE PRONOUNS.

The possessive pronouns are, mio, *my*; tuyo, *thy*, suyo, *his*, *her*, *its*, or *their*; nuestro, *our*; vuestro, *your*. They are declined in the following paradigm:—

Singular.		*Plural.*	
MASCULINE.	FEMININE.	MASCULINE.	FEMININE.
Mio,	mia;	mios,	mias.
Tuyo,	tuya;	tuyos,	tuyas.
Suyo,	suya;	suyos,	suyas.
Nuestro,	nuestra;	nuestros,	nuestras.
Vuestro,	vuestra;	vuestros,	vuestras.

The possessive pronouns *mio*, *tuyo*, and *suyo*, with their feminines, drop their last syllable when they precede the noun to which they belong; as—

Mi padre, mi madre,	*My father, my mother.*
Sus caballos,	*His (her or their) horses.*

If *mio*, *tuyo*, or *suyo* come after the noun to which they belong, the last syllable is retained; as—

¡ Padre mio ! ¡ madre mia !	*My father ! my mother !*
Este libro es suyo,	*This book is his* (or *hers*, or *theirs*).

The possessive pronouns agree in gender and number with the object possessed, and not with the person or thing possessing. Thus, su libro may mean *his book*, *her book*, or *their book ;* sus libros may mean *his books*, *her books*, or *their books*.

The context will generally show whether suyo should be rendered *his*, *her*, or *their*. Otherwise, to prevent ambiguity, de él, *of him ;* de ella, *of her ;* de ellos, *of them* (masc.) ; de ellas, *of them* (fem.) ; de V., *or* de VV., *of you*, are added ; as—

Este libro es suyo de él,	*This book is his*
Este libro es suyo de ella,	*This book is hers.*
Estos libros son suyos de V.,	*These books are yours.*
Estos libros son suyos de ellas,	*These books are theirs* (fem.).

The absolute possessive pronouns *mine*, *thine*, *his own*, *her own*, *its own*, *ours*, *yours*, *theirs*, are formed by placing the definite article before the possessive pronouns : thus, el mio, la mia, los mios, las mias, *mine ;* el nuestro, la nuestra, los nuestros, las nuestras, *ours ;* as—

Su hermano y el mio,	*His brother and mine.*
Tu madre y la mia,	*Thy mother and mine.*
Vuestras hermanas y las mias,	*Your sisters and mine.*

When in English the preposition *of* comes before the absolute possessive pronoun, as in such phrases as "a horse of ours," "a dog of mine," etc., the preposition is not used in Spanish ; as—

Un hijo mio es capitan,	*A son of mine is captain.*

Instead of the personal pronouns, the definite article is used in Spanish when any member or part of the human body is described as being acted upon in such a manner as to make it evident that it refers to the person himself to whom the member or part belongs ; as—

El la tomó por la mano,	*He took her by her (the) hand.*
Ella levantó los ojos,	*She raised her (the) eyes.*

If, however, part of the human body, or parts of dress, be described as acting, or the object of an action, and the article alone would not leave it evident to whom such part belongs, then (instead of a possessive pronoun) a personal pronoun and the definite article are both used ; as—

El *le* tocó *la* mano,	*He touched* the *hand* to-him.
La mano *le* tiembla,	The *hand* to-him *trembles.*
El *le* tomó *las* botas,	*He* to-thee *took* the *boots.*

In these examples the learner will perceive that in English the possessive pronoun alone would have been employed ; for example—*he* touched *his* hand, *his* hand trembles, he took *thy* boots.

To prevent ambiguity, V. or VV. (*your worship* or *your worships*) is often used in addition to the possessive pronoun or the definite article : as, Yo *le* dey á V. muchas grácias, *I* to him *give to your worship many thanks ;* that is, *I give* you *many thanks.* *Sus* or *los* hijos de V., señor, son amables, his *or* the *sons of your worship, sir, are amiable ;* that is, *your sons, sir, are amiable.* Mis hijas y *las suyas de* V. son jóvenes, *my daughters and* yours (his of *your worship*) *are young.*

VOCABULARY.

Cabeza, *head.*
Calle, f., *street.*
Duele, *(it) pains, (it) aches.*
Garganta, *throat.*
Levantó, *(he) raised.*
Mano, f., *hand.*
Ojo, *eye.*
Por, *by, through.*
Sobrino, *nephew.*
Tomó, *(he) took.*

MODEL SENTENCES.

Las casas son suyas, *the houses are his* (or *hers*, or *theirs*).
Los sombreros son suyos de él, *the hats are his.*
Tu hermana y la mia tienen hambre y sed, *thy sister and mine are hungry and thirsty.*
Pedro es amigo mio, *Peter is a friend of mine.*
La muger levantó los ojos, *the woman raised (her) the eyes.*
Le duele la garganta de Pedro, *the throat of Peter pains him ;** i.e, *Peter's throat is sore.*

EXERCISE 11.

Translate into English :—

1. El juez habló á sus amigos. 2. Mi madre tiene hambre. 3. Su criado tiene sed. 4. Su hija tiene tres cucharas. 5. Nuestras criadas son culpables. 6. El libro es mio. 7. La cuchara es tuya. 8. Los sombreros son nuestros. 9. Mi padre me vió. 10. Los caballos son suyos de ella. 11. Las cucharas son suyas de ellos. 12. Las casas son mias. 13. El médico es amigo mio y suyo de él. 14. El dió el libro á un amigo nuestro. 15. El levantó las manos. 16. Ella levantó los ojos. 17. El criado tiene un sombrero en la mano. 18. La cabeza me duele. 19. Me duele la garganta. 20. El pintor le tomó el sombrero, y fué á casa del médico. 21. Mi sobrino levantó la cabeza. 22. V. tiene su dinero. 23. La muger tiene su libro. 24. V. escribió algunas cartas á sus amigos. 25. VV. dieron tres libros á sus criadas. 26. El médico le dió á V. muchos libros. 27. Las casas son suyas de V. 28. Los caballos son suyos de VV. 29. Sus libros de VV. son buenos. 30. V. halló su dinero.

EXERCISE 12.

Translate into Spanish :—

1. My friend is rich. 2. My mother is poor. 3. My friends found a treasure in the road. 4. Thy brother saw a book in the street. 5. A friend of mine found a hat. 6. The physician spoke to his friends. 7. My brother is hungry. 8. His horse is strong. 9. All my books are thine. 10. His female servant is thirsty. 11. I am going to his (or her) house. 12. Our female servants are talkative. 13. The houses are mine. 14. The spoons are hers. 15. The horses are theirs. 16. Thy house and mine (*la mia*) are beautiful. 17. Thy mother and mine have prudence. 18. Thy brothers and mine are very poor. 19. Their sisters and ours are proud. 20.

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* Literally, "to him pains the throat of Peter."

Peter is (a) nephew of mine and hers. 21. The painter is a friend of mine and his. 22. A female servant of mine found a hat in the street. 23. She raised her hands. 24. Peter raised his head. 25. The male servant has a hat on (*en*) his (*la*) head. 26. He took her by her hand. 27. She took him by his hand. 28. His head aches. 29. Peter's head aches. 30. My throat pains me. 31. The physician took his hat, and went to (the) house of the painter. 32. The woman took the hats. 33. You gave a book to your father. 34. You (plur.) gave to your male servants two silver spoons. 35. Your daughters are very beautiful. 36. The oxen are yours. 37. The painter gave you three hats. 38. Your sons are proud. 39. Your sisters are most amiable. 40. You have not your money. 41. The woman has not your book. 42. You wrote not letters to your friends. 43. Your father is rich.

In the last eleven sentences of the above exercise, when the second person (*you* or *your*) occurs, it is to be rendered by V., and its objective cases and possessive pronouns; thus, "you found your book," *V. halló su libro* (literally, your-worship found his book).

RELATIVE PRONOUNS.

The relative pronouns are quien, *who;* el cual, *who, which, that;* que, *who, which, that;* cuyo, *whose*, or *of which*. They are thus declined:—

Singular.		*Plural.*	
MASCULINE.	FEMININE.	MASCULINE.	FEMININE.
Quien		Quienes.	
Que.		Que.	
El cual,*	la cual.	Los cuales,	las cuales.
Cuyo,	cuya.	Cuyos,	cuyas.

Quien always relates to persons, and agrees with its antecedent in gender and number; as—

El general es quien los vió,	*The general is (he) who saw them.*
Las reinas son quienes le maldijeron,	*The queens are (they) who reviled him.*

When *quien* (or *quienes*) is governed by a verb, it is always preceded by the preposition *á;* as—

La dama á quien V. teme,	*The lady whom you fear.*

El cual and *que*, like the relative pronoun *that* in English, relate to both persons and things, agreeing with their antecedent in gender and number. *El cual* is generally to be used to prevent the repetition of *quien* or *que;* as—

La vaca que vió, y de la cual habla, es timida,	*The cow which he saw, and of which he speaks, is timid.*

Cuyo is the possessive relative pronoun, answering to *whose, which*, or *of which*, in English, and agrees with the noun which comes after it; as—

El hombre cuya madre es buena.	*The man whose mother is good.*
La casa cuyos cuartos son espaciosos.	*The house of which the rooms are spacious.*

When the relative pronoun refers to persons, *que* is generally used for *quien*, in the nominative case; but in the objective case *á quien* or, *que* is used (generally the former); as—

El hombre que habla,	*The man who speaks.*
La muger á quien Juan vió, *or* la muger que Juan vio.	*The woman whom John saw.*

If *whom* is preceded by a preposition, *quien* is always used in Spanish; as—

El muchacho para quien él lo hizo,	*The boy for whom he did it.*
Un hombre en quien el rey tiene mucha confianza,	*A man in whom the king has much confidence.*

What, when it means *that which*, is in Spanish *lo que;* when it means *what thing*, it is *que;* and when used before a noun, *what* or *which* is *que* or *cual;* as—

Lo que á algunos gusta á otros disgusta,	*What to some is pleasant, to others is disgusting.*
Yo no se que libros leer, *or* yo no se cuales libros leer.	*I know not what (or which) books to read.*

He who or *he that* is in Spanish el que; *she who*, la que; *they* or *those who*, los que (masc.), las que (fem.). There is also the neuter form, lo que.

In Spanish a preposition is always placed before the relative pronoun which it governs; as—

La ciudad en que yo moro,	*The city in which I dwell.*

The relative pronoun can never be suppressed in Spanish as in English; thus, "the man I saw" must be expressed in full, "the man whom I saw."

VOCABULARY.

Agradable, *agreeable, pleasant.*
Cuarto, *room.*
Ciudad, *city.*
Confianza, *confidence.*
Cuidado, *care, anxiety.*
Decir, *to say.*
Desgraciado, *unfortunate, unhappy.*
Dios, God.
Hacer, *to make, to do.*
Imposible, *impossible.*
Juan, *John.*
Leer, *to read.*
Maria, *Mary.*
Nombre, *name.*
Posible, *possible.*
Sabe, (*he*) *knows.*
Saben, (*they*) *know.*
Sabiduria, *wisdom.*
Tomar, *to take.*

MODEL SENTENCES.

Los pintores á quienes V. vio, y de los cuales Juan hablo, son muy ricos, *the painters whom you saw, and of whom John spoke, are very rich.*

Ella sabe lo que es bueno, *she knows what is good.*

La que tiene dinero, tiene cuidado, *she who has money, has care.*

El hombre cuyo hermano es general del ejército, hallo un tesoro en la ciudad, *the man whose brother is general of the army, found a treasure in the city.*

Mis hermanos son quienes los vio, *my brothers are (they) who saw them.*

EXERCISE 13.

Translate into English:—

1. El hombre á quien el Aleman dió los sombreros, es muy rico ó ignorante. 2. El juez dió los libros á un pintor ingles, en quien el médico tiene mucha confianza. 3. Las mugeres para quienes Pedro escribió las cartas, son muy hermosas y ricas. 4. Las cucharas que María tiene, y las cuales el Frances halló, son mias. 5. Las calles cuyas casas son hermosas, son agradables. 6. Las casas cuyos

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* *Lo cual* is sometimes used instead of *el cual.*

cuartos son espaciosos, son muy agradables. 7. El hombre que tiene prudéncia, es muy sábio. 8. El hombre que tiene dinero, tiene cuidado. 9. Lo que es imposible para los hombres, es posible para Dios. 10. Lo que es nuevo, no es viejo. 11. Pedro ama lo que es bueno. 12. Ella sabe que hacer. 13. El hombre no sabe que hacer. 14. Pedro sabe lo que es bueno. 15. El pintor no sabe que libro leer. 16. La que es sobérbia, no es amable. 17. Los que aman la verdad, son sábios. 18. La que no es agradable, es desgraciada. 19. La muger á quien María habló, es muy amable. 20. El que tiene oro, tiene mucho cuidado. 21. El Aleman dió dos libros al hombre á quien Juan vió.

EXERCISE 14.

Translate into Spanish :—

1. The physician is (he) who wrote the letter which you (*V.*) saw. 2. The Spanish women are (they) who gave the books to Peter. 3. The women to whom the judge wrote the letters are very poor and ignorant. 4. The Frenchwoman whom Peter loves is very beautiful. 5. The German woman whom you (*V.*) saw wrote me many letters. 6. The horse which John saw, and of which (*del cual*) Peter spoke, is strong. 7. The man whose name is John came to my house. 8. The woman whose name is Mary gave me three books. 9. John gave three silver spoons to a woman whose name is Mary. 10. The painter and the printer came to Madrid, in which city the painter found a treasure. 11. The woman who is proud and ignorant is unhappy. 12. The men who have money have cares. 13. That which is possible for Peter is possible for John. 14. The Frenchman has the treasure that the physician found in the street of the city. 15. Mary knows what is good. 16. The painter knows not what to do. 17. The physician's sister knows not what to buy. 18. My brothers know not which books to buy. 19. The Germans know not which hat to take. 20. She knows not what spoon to take. 21. He who has wisdom has prudence. 22. He who has prudence is wise. 23. My father has a treasure which his male servant found in the city. 24. They who gave us the books are our[2] friends.[1] 25. The city in which Peter found the books is large and beautiful. 26. The painter went to Madrid, in which city the streets are pleasant and the houses handsome.

KEY TO EXERCISES.

Ex. 5.—1. The way is narrow. 2. The house is spacious. 3. The women are proud. 4. The Englishmen have no money. 5. The Englishwomen are not hungry. 6. The Spaniards are not thirsty. 7. The American women are handsome. 8. The books are new. 9. A good general is the soul of an army. 10. The Frenchman is poor and proud. 11. The physician's friend is ignorant. 12. The judge is wise and rich. 13. A false tongue does not love truth. 14. The Americans love money. 15. The painter's sons are strong and robust. 16. The poor men are hungry.

Ex. 6.—1. El Frances escribió cartas á la Española. 2. Los Americanos son amigos de los Ingleses. 3. El camino del impio es tenebroso. 4. Las hijas del Españolo son lindas. 5. Los libros son nuevos. 6. La casa del médico es espaciosa. 7. Los caballos del Ingles son fuertes. 8. Los hijos del juez son pobres y sobérbios. 9. La hija de la Francesa es sobérbia é ignorante. 10. Las hermanas del pintor son ricas y hermosas. 11. Un buen hombre ama la verdad. 12. La lengua falaz no ama la verdad. 13. Los Españoles y los Americanos aman dinero. 14. Las cucharas de plata son nuevas. 15. El camino es estrecho. 16. El hijo del juez es malo é ignorante. 17. Los impresores son ricos. 18. El criado del médico es robusto.

Ex. 7.—1. The woman is very amiable. 2. The judge is very old. 3. The man-servant is very culpable. 4. The Spanish language is beautiful and very harmonious. 5. The moon is very brilliant. 6. The stars are very brilliant. 7. The towers are very high. 8. The Spanish women are very proud. 9. The judge is very scrupulous. 10. The house is very high. 11. The ox is as strong as the horse. 12. The painter is more robust than the printer. 13. The maid-servants of the Spanish lady are more talkative than the men-servants of the German. 14. The sun is more brilliant than the moon. 15. The moon is less brilliant than the sun. 16. The physician's daughter is less handsome than the judge's daughter. 17. The houses are not so high as the towers.

Ex. 8.—1. El monte es altísimo. 2. El criado es muy viejo. 3. La lengua española es bella e muy armoniosa. 4. El sol es muy brilliante. 5. Las estrellas son muy brilliantes. 6. El pintor es tan sobérbio que el juez. 7. El caballo es tan fuerte como el buey. 8. El carpintero es tan rico que el impresor. 9. Las hijas de la Alemana son ménos culpables que las hijas de la Española. 10. Las estrellas son ménos brilliantes que la luna. 11. El leon es mas fuerte que el caballo. 12. El juez es mas sábio que el médico.

Ex. 9.—1. Peter wrote me two letters. 2. She gave him a book. 3. He found them. 4. She wrote to them some letters. 5. The physician spoke to them. 6. I am poor and old. 7. Thou art very wise. 8. He is ignorant. 9. We are strong and rich. 10. The painter gave thee a silver spoon. 11. The woman saw us. 12. The carpenter spoke to us. 13. The Spaniards spoke to him. 14. The judge has much confidence in you. 15. Peter gave you the book. 16. The German did not give you the money. 17. The German lady did not speak to you. 18. The woman did not speak to me. 19. The painter saw thee not. 20. The carpenter did not find them. 21. I am going to give you a book. 22. You are rich. 23. You (plur.) are poor. 24. You (plur.) are proud.

Ex. 10.—1. Pedro me escribió dos cartas. 2. El pintor le dió un libro. 3. Ella los halló. 4. El les escribio algunas cartas. 5. Yo soy pobre y viejo. 6. El juez les habló. 7. Tu eres muy rico. 8. Él es sábio. 9. Nosotros somos ignorantes. 10. Ellos son fuertes y ricos. 11. El pintor te dió una cuchara de plata 12. La muger nos vió. 13. El carpintero nos habló. 14. La Española le habló. 15. El médico le vió. 16. La Francesa los vió. 17. La Alemana las vió. 18. El carpintero lo hizo para él. 19. El pintor tiene confianza en ella. 20. Los impresores tienen mucha confianza en él. 21. El Ingles lo hizo para mi. 22. V. me dió un libro. 23. V. es muy sábio. 24. V. tiene hambre. 25. V. tiene una casa. 26. VV. tienen sed. 27. VV. no son soberbios. 28. VV. aman la verdad. 29. El médico tiene mucha confianza en V. 30. Yo voy á darle un libro.

ELECTRICITY.—XVI.

[*Continued from Vol. VI., p. 339.*]

ACCUMULATORS.

THE thermo-electric battery will continue to supply a current as long as energy in the form of heat is expended on it, but the voltaic battery will only continue to supply a current till the positive element—which is the fuel—becomes consumed. The current is generated by the expenditure of the energy stored up in the positive element, and will be generated—under suitable circumstances—till that store becomes exhausted. If we have any means of renewing the store, we increase the length of time during which the current will be generated. In the case of an ordinary zinc and copper cell, if we send a current backwards through it, that is to say, if the current enters the cell through the copper, and leaves it at the zinc, it will be found that a certain amount of zinc will be deposited from the solution on the zinc rod. The nature of the deposited zinc does not now concern us; it is sufficient to know that by expending energy in the form of current on the cell we deposit zinc, and thereby increase the store of energy existing in the cell. The primary battery is thus *reversible*, and in its reversible form it is known as a *secondary battery*, or as an *accumulator*. An accumulator is, therefore, a combination of materials upon which energy, in the form of current, can be expended, and which thereby acquires the property of generating a current on a subsequent occasion.

If a current be sent through a dilute solution of sulphuric acid by means of two platinum plates immersed in it, the water in the solution will be decomposed, oxygen will be evolved at the plate by which the current enters the liquid, and hydrogen at the plate by which it leaves it. If the generating source be now withdrawn, it will be found that the platinum plates immersed in the acid have acquired the power of generating a current, whose direction is in an opposite direction to the original one. The explanation of the phenomenon is that the platinum plates have been covered with layers of hydrogen and oxygen respectively, and as hydrogen is a fairly good fuel, it acts as the positive element for generating a current when the original source is withdrawn. Such an arrangement of materials is an accumulator, but it is an accumulator of very small capacity, since the amount of hydrogen that can be stored upon the surface of a platinum plate is an extremely small quantity. The capacity of such an accumulator can be increased by increasing the area of the platinum plates, but under no circumstances can it be rendered sufficiently large to be of any commercial value.

THE PLANTÉ ACCUMULATOR.

It will be noticed that in the above-mentioned experiment the platinum is not acted upon chemically, and therefore plays no active part in the working of the accumulator. If other substances be substituted for platinum very different results will be obtained, owing to the fact that they are chemically acted upon by the evolved gases. Lead is the substance which is almost universally used in modern accumulators, and the researches on this substance by Gaston Planté have laid the foundation for all future development. If lead be substituted for platinum in the above experiment, hydrogen will be formed on one plate as before, but the oxygen on the other will enter into chemical combination with the lead, and will form on that plate a film of peroxide of lead. This is a chocolate-coloured substance, which sticks firmly to the plate, and which consists of two particles of oxygen in combination with one of lead. The other plate will be covered with a layer of hydrogen, and will turn a greyish colour, but no chemical action will take place. If the source be now withdrawn, the accumulator can send a current for a short time, but its capacity is very small. When it is completely discharged, the source is again applied, but in such a way as to send a current through the accumulator in the opposite direction to the first charging current. A film of peroxide of lead will now be formed on the surface of the plate which was previously unacted upon, and the other plate will become covered with hydrogen. The accumulator is now discharged and again charged, as in the first instance. This alternate charging and discharging in opposite directions is continued for a long time with the following results:—Each successive charging takes a longer time than the preceding one, which means that the capacity increases with each charging. The accumulator is completely charged when the gases begin to rise through the liquid from the plates, since this means that the plates have become completely covered with their respective layers. This alternate charging and discharging is known as forming the plates, and its object is to expose as large an amount of surface to chemical action as possible. At each charging the oxygen attacks a fresh portion of the lead, so that the plates in the course of time become thoroughly honeycombed, and expose an extremely large area to useful chemical action. The reversing of the current perforates both plates in the same manner, so that when the accumulator is finally charged and ready for use, one plate consists of pure lead thoroughly honeycombed all over and covered with a layer of hydrogen, and the other of peroxide of lead, with a small amount of oxygen and ozone. The lead plate now acts as the fuel in order to generate a current, and it becomes burnt up or oxidised in the process. For this reason it should be called the positive plate, but both the general public and manufacturers have got accustomed to call it the negative. In order to avoid any possible confusion on this subject, the true positive or pure lead plate will in this lesson be called the grey plate, and the true negative or peroxide plate will be called the brown plate. The terminal of the brown plate is almost invariably painted red, and the terminal of the grey plate black.

On commencing to discharge such an accumulator the initial E.M.F. is about 2·5 volts, but after a short time this falls to between 2 and 2·1, which may be looked upon as its normal working E.M.F. The high E.M.F. at starting is due to the gases on the surface of the plates, but these are quickly exhausted, and the effective working substances are then the pure lead on one plate and the peroxide of lead on the other.

The process of making the Planté accumulator is illustrated in Fig. 84. Two rectangular sheets of lead, each having a projecting lug to serve as a terminal, are laid one above the other, but separated from each other by two india-rubber bands; these are then rolled into the form of a cylinder, as shown in the left-hand side of the figure, and are maintained in this position by an ebonite cross placed on the top. The whole is then immersed in sulphuric acid of the strength 1 in 10, and the forming process commenced. The accumulator is allowed to rest for some 10 or 15 minutes, fully charged, before the current is reversed. The forming process takes several months to carry out, and when completed, one plate is largely reduced to the condition of spongy lead—lead in a finely divided state—and the other consists principally of peroxide of lead.

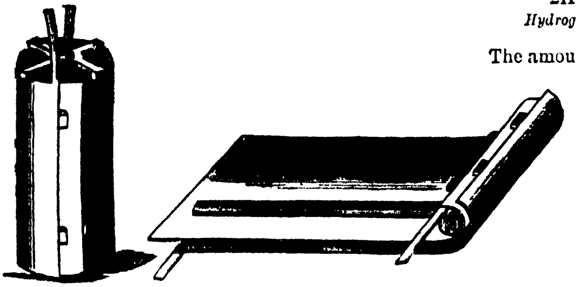

Fig. 84.—The Planté Accumulator.

CHEMICAL ACTION.

The brown plate is composed of two substances—a lead core in contact with a peroxide coating; and as these two substances occupy widely different positions as regards their heat values, it is natural to expect that local action would take place between them when both are immersed in sulphuric acid. As a matter of fact, this local action does take place, and takes place to a considerable extent during the interval that the accumulator is allowed to rest between charging and discharging. The effect of this local action is to still further attack the lead core, and to form lead sulphate ($PbSO_4$), and a layer of this substance thus gets interposed between the core and its coating. Lead sulphate is insoluble in sulphuric acid, and is a very bad conductor, so that its formation between the peroxide and the lead practically checks further local action. Planté recommends the 10-minute interval between the charging and discharging, in order to allow this local action to take place, since by its means more of the lead core is rendered active material. When the current is reversed, the sulphate gets reduced by the hydrogen evolved by the decomposition of the acid, thus:—

$$\begin{array}{ccccccc} 2H & + & PbSO_4 & = & H_2SO_4 & + & Pb. \\ \textit{Hydrogen.} & & \textit{Lead sulphate.} & & \textit{Sulphuric acid.} & & \textit{Lead.} \end{array}$$

The amount of this sulphate that forms on the plate depends upon the length of time that the accumulator is allowed to remain charged; and if the time be considerable, nearly all the peroxide may be converted into sulphate, and the accumulator thus lose its charge.

IMPROVEMENTS IN ACCUMULATORS.

The process of formation of the Planté accumulator is long, tedious, and expensive; and when completed, there is too little space allowed for the free circulation of the acid between the plates, and too great a liability of the accumulator getting short-circuited. Again, peroxide of lead is a bad conductor; and when one plate gets almost completely converted into this substance, the resistance of the accumulator increases enormously, whilst at the same time the other plate, being almost completely converted into spongy lead, is liable to disintegrate and fall to pieces on the slightest provocation. The improvements in the modern accumulators over the original forms of Planté consist almost entirely in devices for overcoming the faults just mentioned.

In modern paste accumulators the time of formation is reduced from a question of months to hours, plenty of space is allowed for the circulation of the acid, and the mechanical arrangement of the plates is such as to allow only the smallest possible chance of short-circuiting. The plates consist of two portions—a framework (usually known as the grid), which is not chemically acted upon to any appreciable extent in the working of the cell, but which serves the double purpose of holding the active material in the desired position and of conducting the current from that material to the terminals: the active material consists of paste, which can almost wholly be converted either into peroxide or spongy lead.

LEAD AND ITS OXIDES.

Lead occurs in nature principally in combination with sulphur to form lead sulphide, PbS, usually known as galena. It is obtained in the pure state by roasting the galena in a reverberatory furnace. It is a fairly good fuel, though not as good as zinc; in a finely divided state it will take fire in the atmosphere at the ordinary temperature. In a dry atmosphere or in pure water it is not attacked, but if any moisture be present in the air, or any air in the water, it becomes quickly oxidised and tarnishes.

Oxides of Lead.

Pb_2O.—Lead suboxide.

PbO.—Lead monoxide. Also called litharge or massicot.

PbO_2.—Lead dioxide or peroxide. Also called minium.

Pb_3O_4.—Red lead, or oxide. This is a mixture of the two previous oxides in the proportion of two of the former to one of the latter.

Pb_2O_3.—Lead sesquioxide. A combination of the monoxide and dioxide in equal parts.

Of these oxides of lead, the first and last are unimportant as far as accumulators are concerned, but the other three are all important.

PbO.—Lead monoxide is obtained by heating lead in the presence of air, and takes the form of a yellow powder. When heated to redness it fuses, and crystallises in flakes, and in this form it is known as litharge or massicot.

PbO_2.—Lead peroxide is a brown powder of a highly oxidising nature, and is the substance with which the brown plate is covered when the accumulator is fully charged.

Pb_3O_4.—Red lead is obtained by heating lead monoxide to a moderate temperature in the presence of air.

GRIDS OF PASTE ACCUMULATORS.

The grids are rectangular in shape, and consist of an alloy of lead and a little antimony. They are cast in iron or steel moulds which are heated almost to the melting-point of the alloy, and are allowed to cool as soon as the metal has been poured in. Fig. 85 shows one of the E.P.S. accumulators, in which the grid of the outside plate is represented by the light lines. A thick band of alloy surrounds the grid and a number of strengthening pieces are shown passing through it. These grids hold the paste—which is the active material in the accumulator—in position, and must on no account allow any of it to drop out, as such an accident might short-circuit the accumulator by bridging over the distance between the two plates. A section through the grid of an E.P.S. accumulator is shown in Fig. 86 In this figure the shaded portion denotes the grid and the unshaded portion the space for the paste—in the lower portion of the figure the paste is shown filled in. It is thus seen that the paste is keyed in, and cannot fall out unless it breaks along the central line, which is an unusual accident. The grid for the brown plate is cast somewhat more substantially than the one for the grey plate, as it is subjected to greater buckling strains. A number of plates are usually placed in the accumulator in order to increase its capacity, and there is always one more of the grey than of the brown plates, thus forming an unequal number of plates in each accumulator and having the two outside ones always grey. Each grey plate has two feet and a lug cast on it, and both the feet and lugs of all these plates are burnt to substantial lead bands as shown; lead bands are also burnt to them about half way up at each side. All the grey plates are thus firmly connected to one another at five places, and such an arrangement is known as a *section*. The brown plates have lugs

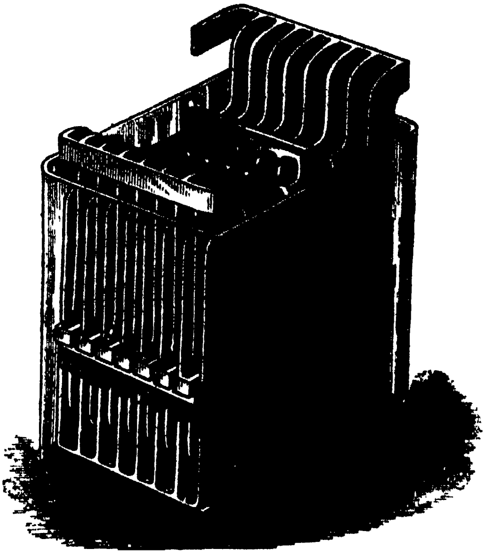

Fig. 85.—E.P.S. Accumulator.

but no feet, and are connected together by the lead band burnt to the tops of the plates, and by the connections at the lugs. The legs of the grey plates rest on pieces of wood placed at the bottom of the vessel, and the brown plates rest by means of little projections on the horizontal bands joining the grey plates, but are, of course, insulated from them. The distance between the plates is about ⅜ inch, and this distance is maintained by the forked celluloid separators which run over each plate as shown.

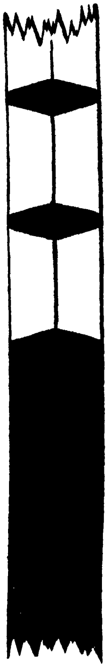

Fig. 86.—Section of E.P.S. Grid.

PASTE.

Brown Plates.—Mix red lead with sulphuric acid of the strength of one in eight, so as to form a soft paste, and immediately fill up all the spaces in the grid. No time must be lost in the mixing of the paste and the placing of it in position, and it is advisable only to mix sufficient paste for one or two plates at a time. The necessity for haste in the operation arises from the fact that the addition of sulphuric acid to the red lead converts the latter into lead sulphate and peroxide, and this reaction should not be completed before the paste has been placed in its final position. The chemical reaction that takes place is as follows:—

$$\underset{\textit{Red lead.}}{Pb_3O_4} + \underset{\textit{Sulphuric acid.}}{2H_2SO_4} = \underset{\textit{Peroxide of lead.}}{PbO_2} + \underset{\textit{Lead sulphate.}}{2PbSO_4} + \underset{\textit{Water.}}{2H_2O}.$$

The brown plate thus consists of peroxide and sulphate of lead when the operation is finished, and both of these substances are insoluble in sulphuric acid.

Grey Plates.—The operation is similar to the above, but litharge is substituted for red lead, and the acid is of the strength one in twenty.

FORMATION OF THE PLATES.

Brown Plates.—The plates are all placed in a shallow vessel, and their terminals all connected together and to the positive terminal of a dynamo. Acid of the strength one in four is then run in so as to cover the plates, and the current is immediately started and kept on continuously for about twenty hours. At the end of that time, practically all the paste has been converted into peroxide of lead, as can be recognised by the chocolate colour, and the process of formation is complete.

Grey Plates.—The grey plates are all connected up in a similar manner, but to the negative terminal of the dynamo. Acid of the strength one in twenty is used, and a weak current is kept on for about a week before the formation is complete. It is useless to employ a strong current, since the energy is expended in decomposing the acid and evolving hydrogen, whilst the process of formation is not hastened.

SULPHURIC ACID.

The acid used in both the construction and maintenance of accumulators should be free from arsenic, which occurs as an impurity in the common commercial acid made from iron pyrites; that made from native sulphur is the best. The density of the acid in an accumulator should never be less than 1·100 nor greater than 1·200:—

15% acid has a density of 1·106
27% „ „ „ 1·198

When the accumulator is fully charged, the density of the acid is at its maximum, and when fully discharged at a minimum; and between these limits the charge in the accumulator is almost proportional to the density of the acid. It is therefore only necessary to know the density of the acid in the accumulator—which may be found by immersing a hydrometer—in order to have a very good idea of the amount of its charge The level of the liquid gradually sinks in an accumulator owing to evaporation, and to the liquid carried off in spray when charging. Water alone is lost by evaporation, but both water and acid are lost by spraying. This defect must be made up by the addition of dilute acid, and the tops of the plates must on no account be ever allowed to project above the liquid.

CHARGING.

When accumulators come from the manufacturers and are set up, they must be charged—continuously if possible—for about thirty hours, when they will begin to boil. By boiling is meant the free evolution of hydrogen in the form of bubbles from the liquid; this indicates that the accumulator is fully charged The strength of current should be at the rate of not greater than 6 amperes per square foot of brown plate, which means about 4 amperes for every brown plate. When a number of accumulators are connected up in series, the charging should be continued till they all boil equally. The proper strength of current is obtained when the E.M.F. of the dynamo is about 10 per cent higher than the E.M.F. of the accumulators, but as the E.M.F. of the accumulators is small at starting, that of the dynamo should be regulated accordingly. A series-wound dynamo should on no account be used for charging, since if the E.M.F. of the accumulators owing to any circumstance overcame that of the dynamo—which might happen through the engine slowing down or some such accidental cause—the accumulators would send a current backwards through the dynamo and reverse its magnetism: when the engine then regained its proper speed, the current would flow in the wrong direction through the accumulators and possibly ruin them unless the accident was discovered in time. A shunt dynamo should be used, since a discharge backwards only strengthens without reversing its magnetism. The reaction which occurs in the charging of an accumulator is as follows:—

$$\underset{\textit{Lead sulphate.}}{PbSO_4} + \underset{\textit{Water.}}{H_2O} + \underset{\textit{Sulphuric acid.}}{H_2SO_4} + \underset{\textit{Lead monoxide.}}{PbO} =$$

$$\underset{\textit{Lead peroxide.}}{PbO_2} + \underset{\textit{Sulphuric acid.}}{2H_2SO_4} + \underset{\textit{Lead.}}{Pb.}$$

A molecule of sulphuric acid is thus added to the liquid, which therefore becomes denser, and consequently a better conductor. A fully charged accumulator has only about half the resistance of an uncharged one.

DISCHARGING.

An accumulator should not be discharged at a greater rate than the maximum charging current, but may be discharged at any lower rate than this. The resistance of an accumulator is almost inversely proportional to the current that it is giving, so that the terminal E.M.F. remains practically constant, no matter what current it is giving. This fact, as can easily be seen, is of immense advantage when working on a constant potential circuit, such as would be required for glow-lamps. Discharge should never be carried beyond 75 per cent. of the total charge in the battery; beyond this point the E.M.F. begins to fall rapidly. The average working efficiency of an accumulator is between 65 and 70 per cent.

SULPHATING.

The cause of failure of an accumulator in nine cases out of ten is due to sulphating; this means the formation of the higher sulphate of lead (Pb_2SO_5) on the brown plate. It first appears in the form of white spots on the brown plate, which quickly spread over its whole surface if steps are not immediately taken to arrest it. It is usually due to one of the following causes:—

(1) Discharging the accumulator beyond the point where the E.M.F. begins to fall rapidly.

(2). Allowing the acid to become too weak or too strong.

(3). Short-circuiting.

(4). Allowing the accumulator to remain for a considerable time unused.

Short-circuiting may be caused by a piece of paste or any foreign substance falling between and bridging over the gap between any two plates; or it may be caused by the buckling of one or more plates till a pair of them touch. A short circuit can always be detected by that cell showing no tendency to boil when all the others are boiling. It may also be detected by an observation with the hydrometer; if the density of the acid is low when the cell is supposed to be charged, the fault can usually be traced to the more or less partial short-circuiting of the plates. The immediate effect of sulphating is to lower the capacity, as that portion of the plate which is sulphated is rendered ineffective. The cure for sulphating is simple, but is only effective when taken at an early stage: continual charging with a moderate strength of current till all traces of white have disappeared from the brown plate. During the process of reducing the sulphate the cell should on no account be used for generating a current till all traces of the white spots have been cleared off. The reduction of the sulphate is hastened by the addition of a little caustic soda to the liquid. The soda should not be added plain, but should be dissolved in water—1 oz. to 5 gallons—and some of this solution added. If the sulphate has spread over the whole plate, the section should be withdrawn, and each plate scrubbed with a wire brush and dilute acid till all the sulphate has been removed. The section is then replaced, and the accumulator well charged. When accumulators are not used for a considerable length of time, they should be charged regularly once a month in order to maintain them in good working order, otherwise they may lose their charge by slow leakage and become badly sulphated.

TRIBE'S EXPERIMENTS.

The curious manner in which the deposit occurs on insulated conducting plates is shown in the coloured plate given in Volume VI.

In all the figures given there the arrows indicate the direction in which the current was passing. Fig. 1 shows the nature of the deposit on a sphere. Figs. 2 and 3, the deposits on egg-shaped bodies when the current flowed as indicated. Figs. 4, 5, and 6, the deposits on triangular plates of the same area when the current flowed at right angles to their planes. Figs. 7 and 8, the deposits on the outside and inside of a tube respectively, when the current flowed in the direction of its length. Figs. 9, 10, and 11, the deposits on plates when the current flowed in the direction of their length, and when the E.M.F. was gradually increased.

GERMAN.—XXXVII.

[*Continued from Vol. VI., p. 378.*]

ALPHABETICAL LIST OF VERBS OF THE OLD FORM

(*Commonly called Irregular Verbs*) (*continued*).

INFINITIVE.	INDICATIVE. *Present.*	INDICATIVE. *Past.*	SUBJUNCTIVE. *Past.*	IMPERATIVE.	PARTICIPLE.
Scheiden, to separate	ich ſcheide, ꝛc.	ich ſchied	ich ſchiede	ſcheide	geſchieden
Scheinen, to appear	ich ſcheine, ꝛc.	ich ſchien	ich ſchiene	ſcheine	geſchienen
Schelten, to scold	ich ſchelte, du ſchiltſt, er ſchilt	ich ſchalt (ſcholt)	ich ſchälte (ſchölte)	ſchilt	geſcholten
Scheeren, to shear	ich ſcheere, ꝛc.	ich ſchor	ich ſchöre	ſcheere, ſchier	geſchoren
Schieben, to shove	ich ſchiebe, ꝛc.	ich ſchob	ich ſchöbe	ſchiebe	geſchoben
Schießen, to shoot	ich ſchieße, ꝛc.	ich ſchoß	ich ſchöſſe	ſchieße	geſchoſſen
Schinden, to flay	ich ſchinde, ꝛc.	ich ſchund	ich ſchünde	ſchinde	geſchunden
Schlafen, to sleep	ich ſchlafe, du ſchläfſt, er ſchläft	ich ſchlief	ich ſchliefe	ſchlafe	geſchlafen
Schlagen, (38) to beat	ich ſchlage, du ſchlägſt, er ſchlägt	ich ſchlug	ich ſchlüge	ſchlage	geſchlagen
Schleichen, to sneak	ich ſchleiche, ꝛc.	ich ſchlich	ich ſchliche	ſchleiche	geſchlichen
Schleifen, (39) to whet, to sharpen	ich ſchleife, ꝛc.	ich ſchliff	ich ſchliffe	ſchleife	geſchliffen
Schleißen, to slit	ich ſchleiße, ꝛc.	ich ſchliß	ich ſchliſſe	ſchleiße	geſchliſſen
Schließen, to shut	ich ſchließe, ꝛc.	ich ſchloß	ich ſchlöſſe	ſchließe	geſchloſſen
Schlingen, to sling	ich ſchlinge, ꝛc.	ich ſchlang	ich ſchlänge	ſchlinge	geſchlungen
Schmeißen, to fling	ich ſchmeiße, ꝛc.	ich ſchmiß	ich ſchmiſſe	ſchmeiße	geſchmiſſen
Schmelzen, to melt	ich ſchmelze, du ſchmilzeſt *or* ſchmelzeſt, er ſchmilzt *or* ſchmelzt	ich ſchmolz	ich ſchmölze	ſchmilz *or* ſchmelze	geſchmolzen
Schnauben, to snort	ich ſchnaube	ich ſchnob	ich ſchnöbe	ſchnaube	geſchnoben
Schneiden, to cut	ich ſchneide, ꝛc.	ich ſchnitt	ich ſchnitte	ſchneide	geſchnitten
Schrauben, to screw	ich ſchraube, ꝛc.	ich ſchraubte (ſchrob)	ich ſchraubte (ſchröbe)	ſchraube	geſchraubt (geſchroben)
Schreiben, to write	ich ſchreibe, ꝛc.	ich ſchrieb	ich ſchriebe	ſchreibe	geſchrieben
Schreien, to cry	ich ſchreie, ꝛc.	ich ſchrie	ich ſchriee	ſchreie	geſchrieen
Schreiten, to stride	ich ſchreite, ꝛc.	ich ſchritt	ich ſchritte	ſchreite	geſchritten
Schroten, to grind roughly	ich ſchrote, ꝛc.	ich ſchrotete	ich ſchrotete	ſchrote	geſchroten, geſchrotet
Schwären, to suppurate	ich ſchwäre, ꝛc.	ich ſchwor	ich ſchwöre	ſchwäre	geſchworen
Schweigen, to be silent	ich ſchweige, ꝛc.	ich ſchwieg	ich ſchwiege	ſchweige	geſchwiegen
Schwellen, to swell	ich ſchwelle, du ſchwillſt, er ſchwillt	ich ſchwoll	ich ſchwölle	ſchwill *or* ſchwelle	geſchwollen
Schwimmen, to swim	ich ſchwimme, ꝛc.	ich ſchwamm	ich ſchwämme, ſchwömme	ſchwimme	geſchwommen
Schwinden, to vanish	ich ſchwinde, ꝛc.	ich ſchwand	ich ſchwände	ſchwinde	geſchwunden
Schwingen, to swing	ich ſchwinge, ꝛc.	ich ſchwang	ich ſchwänge	ſchwinge	geſchwungen
Schwören, to swear	ich ſchwöre, ꝛc.	ich ſchwor *or* ſchwur	ich ſchwöre *or* ſchwüre	ſchwöre	geſchworen
Sehen, to see	ich ſehe, du ſiehſt, er ſieht	ich ſah	ich ſähe	ſiehe, ſieh	geſehen
Sein, to be	ich bin, ꝛc.	ich war, ꝛc.	ich wäre	ſei	geweſen
Senden, to send	ich ſende, ꝛc.	ich ſandte *and* ſendete	ich ſendete	ſende	geſandt *and* geſendet
Sieden, to boil	ich ſiede, ꝛc.	ich ſott	ich ſötte	ſiede	geſotten
Singen, to sing	ich ſinge, ꝛc.	ich ſang	ich ſänge	ſinge	geſungen
Sinken, to sink	ich ſinke, ꝛc.	ich ſank	ich ſänke	ſinke	geſunken
Sinnen, to think, to muse	ich ſinne, ꝛc.	ich ſann	ich ſänne (ſönne)	ſinne	geſonnen
Sitzen, to sit	ich ſitze, ꝛc.	ich ſaß	ich ſäße	ſitze	geſeſſen
Sollen, to be obliged	ich ſoll, du ſollſt, er ſoll	ich ſollte	ich ſollte	ſolle	geſollt

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(38) **Rathſchlagen** and berathſchlagen, *to consult*, are regular. (39) Regular in all other significations, as *to demolish* or *to drag*.

INFINITIVE.	INDICATIVE. *Present.*	INDICATIVE. *Past.*	SUBJUNCTIVE. *Past.*	IMPERATIVE.	PARTICIPLE.
Spalten, to split	ich ſpalte, ꝛc.	ich ſpaltete	ich ſpaltete	ſpalte	geſpalten, geſpaltet
Speien, to spit	ich ſpeie, ꝛc.	ich ſpie	ich ſpiee	ſpeie	geſpieen
Spinnen, to spin	ich ſpinne, ꝛc.	ich ſpann	ich ſpänne (ſpönne)	ſpinne	geſponnen
Spleißen, to split	ich ſpleiße, ꝛc.	ich ſpliß	ich ſpliſſe	ſpleiße	geſpliſſen
Sprechen, to speak	ich ſpreche, du ſprichſt, er er ſpricht	ich ſprach	ich ſpräche	ſprich	geſprochen
Sprießen, (40) to sprout	ich ſprieße, ꝛc.	ich ſproß	ich ſpröſſe	ſprieße	geſproſſen
Springen, to spring	ich ſpringe, ꝛc.	ich ſprang	ich ſpränge	ſpringe	geſprungen
Stechen, to sting, to prick	ich ſteche, du ſtichſt, er ſticht	ich ſtach	ich ſtäche	ſtich	geſtochen
Stehen, to stand	ich ſtehe, ꝛc.	ich ſtand, ſtund	ich ſtände, ſtünde	ſtehe	geſtanden
Stehlen, to steal	ich ſtehle, du ſtiehlſt, er ſtiehlt	ich ſtahl	ich ſtähle, ſtöhle	ſtiehl	geſtohlen
Steigen, to ascend	ich ſteige, ꝛc.	ich ſtieg	ich ſtiege	ſteige	geſtiegen
Sterben, to die	ich ſterbe, du ſtirbſt, er ſtirbt	ich ſtarb	ich ſtärbe, ſtürbe	ſtirb	geſtorben
Stieben, (41) to fly (as dust)	ich ſtiebe, ꝛc	ich ſtob	ich ſtobe	ſtiebe	geſtoben
Stinken, to stink	ich ſtinke, ꝛc	ich ſtank	ich ſtänke	ſtinke	geſtunken
Stoßen, to push	ich ſtoße, du ſtößeſt, er ſtößt	ich ſtieß	ich ſtieße	ſtoße	geſtoßen
Streichen, to stroke	ich ſtreiche, ꝛc.	ich ſtrich	ich ſtriche	ſtreiche	geſtrichen
Streiten, to contend	ich ſtreite, ꝛc.	ich ſtritt	ich ſtritte	ſtreite	geſtritten
Thun, to do	ich thue, du thuſt, er thut	ich that	ich thäte	thue	gethan
Tragen, to bear	ich trage, du trägſt, er trägt	ich trug	ich trüge	trage	getragen
Treffen, to hit	ich treffe, du triffſt, er trifft	ich traf	ich träfe	triff	getroffen
Treiben, to drive	ich treibe, ꝛc.	ich trieb	ich triebe	treibe	getrieben
Treten, to tread	ich trete, du trittſt, er tritt	ich trat	ich träte	tritt	getreten
Triefen, to drop, to trickle	ich triefe, ꝛc.	ich troff	ich troffe	triefe	getroffen
Trinken, to drink	ich trinke, ꝛc.	ich trank	ich tränke	trinke	getrunken
Verbleichen, to die, grow pale	ich verbleiche, ꝛc.	ich verblich	ich verbliche	verbleiche	verblichen
Verderben, (42) to perish	ich verderbe, du verdirbſt, er verdirbt	ich verdarb	ich verdärbe, verdurbe	verdirb	verdorben
Verdrießen, to vex	es verdrießt	es verdroß	es verdroſſe	verdrieße	verdroſſen
Vergeſſen, to forget	ich vergeſſe, du vergiſſeſt, er vergißt	ich vergaß	ich vergäße	vergiß	vergeſſen
Verhehlen, to conceal	ich verhehle, ꝛc.	ich verhehlte	ich verhehlte	verhehle	verhehlt *or* verhehlen
Verlieren, to loose	ich verliere, ꝛc.	ich verlor	ich verlöre	verliere	verloren
Verlöſchen, to extinguish	ich verloſche, du verlöſcheſt *or* verliſcheſt, er verlöſcht *or* verliſcht	ich verloſch	ich verloſche	verlöſche *or* verliſch	verloſchen
Verſchallen, (43) to die away in sound	ich verſchalle, ꝛc.	ich verſcholl	ich verſchölle	verſchalle	verſchollen
Verwirren, to perplex	ich verwirre, ꝛc.	ich verwirrte	ich verwirrte	verwirre	verwirrt *or* verworren
Wachſen, to grow	ich wachſe, du wächſeſt, er wächſt	ich wuchs	ich wüchſe	wachſe	gewachſen
Wägen *or* Wiegen, (44) to weigh	ich wäge *or* wiege, du wägſt *or* wiegſt, er wägt *or* wiegt	ich wog	ich wöge	wage *or* wiege	gewogen
Waſchen, to wash	ich waſche, du wäſchſt, er wäſcht	ich wuſch	ich wuſche	waſche	gewaſchen
Weben, (45) to weave	ich webe, ꝛc.	ich wob	ich wöbe	webe	gewoben

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(40) Always used with ſein as its auxiliary. (41) Also active in the sense of *to set suddenly in motion.* (42) Verderben, *to destroy* (active), is also used regular. (43) But little used, except in the past and participle. (44) Wägen is transitive, and wiegen is intransitive. Wiegen, *to rock*, is regular. (45) Regular, except with the poets, or when used figuratively.

INFINITIVE.	INDICATIVE. *Present.*	INDICATIVE. *Past.*	SUBJUNCTIVE *Past.*	IMPERATIVE.	PARTICIPLE.
Weichen, (46) to yield	ich weiche, ꝛc.	ich wich	ich wiche	weiche	gewichen
Weiſen, to show	ich weiſe, ꝛc.	ich wies	ich wieſe	weiſe	gewieſen
Wenden, to turn	ich wende, ꝛc.	ich wendete *or* wandte	ich wendete	wende	gewendet *or* gewandt
Werben, to sue for	ich werbe, du wirbſt, er wirbt	ich warb	ich würbe	wirb	geworben
Werden, to become	ich werde, du wirſt, er wird	ich ward *or* wurde, ꝛc.	ich würde	werde	geworden; (auxiliary) worden
Werfen, to throw	ich werfe, du wirfſt, er wirft	ich warf	ich wärfe, würfe	wirf	geworfen
Winden, to wind	ich winde, ꝛc.	ich wand	ich wände	winde	gewunden
Wiſſen, to know	ich weiß, du weißt, er weiß	ich wußte	ich wüßte	wiſſe	gewußt
Wollen, to will	ich will, du willſt, er will	ich wollte	ich wollte	wolle	gewollt
Zeihen, to accuse of	ich zeihe, ꝛc.	ich zieh	ich ziehe	zeihe	geziehen
Ziehen, (47) to draw	ich ziehe, ꝛc.	ich zog	ich zöge	ziehe	gezogen
Zwingen, to force	ich zwinge, ꝛc.	ich zwang	ich zwänge	zwinge	gezwungen

(46) **Weichen**, *to soften*, *to nullify*, is regular. (47) Zeuchſt, etc., antiquated, and only in poetical usage.

OF THE NEW CONJUGATION

(*Commonly called Regular Verbs*).

In verbs of the New (or Weak) Form, the past tense and the past participle are not produced, as in the Old Conjugation, by a change of the radical vowels, but by means of the suffix -et or -t, which serves as a *tense characteristic.* Thus, taking the radical part (lob-) of loben, *to praise*, and affixing thereto -et or -t, we get lobet or lobt, to which add the *personal* endings, and we have lobete (lob + et + e) or lobte, *I praised*; lobeteſt or lobteſt, *thou didst praise*, etc.

The verbs of the New Form differ again from those of the Old, the former having in the past participle the termination -et or -t, instead of -en; as, gelobet or gelobt, *praised.*

PARADIGM OF A VERB OF THE NEW FORM.

Loben, *to praise*, is thus conjugated :—

INDICATIVE MOOD.

	PRESENT.		PAST.
Sing.	Ich lobe, I praise.	*Sing.*	Ich lobte, I praised.
	Du lobſt.		Du lobteſt.
	Er lobt.		Er lobte.
Plur.	Wir loben.	*Plur.*	Wir lobten.
	Ihr lobt.		Ihr lobtet.
	Sie loben.		Sie lobten.

	PRESENT PERFECT.		PLUPERFECT.
Sing.	Ich habe gelobt, I have praised.	*Sing.*	Ich hatte gelobt, I had praised.
	Du haſt gelobt.		Du hatteſt gelobt.
	Er hat gelobt.		Er hatte gelobt.
Plur.	Wir haben gelobt.	*Plur.*	Wir hatten gelobt.
	Ihr habt gelobt.		Ihr hattet gelobt.
	Sie haben gelobt.		Sie hatten gelobt.

	FUTURE IMPERFECT.		FUTURE PERFECT.
Sing.	Ich werde loben, I shall praise.	*Sing.*	Ich werde gelobt haben, I shall have praised.
	Du wirſt loben.		Du wirſt gelobt haben.
	Er wird loben.		Er wird gelobt haben.
Plur.	Wir werden loben.	*Plur.*	Wir werden gelobt haben.
	Ihr werdet loben.		Ihr werdet gelobt haben.
	Sie werden loben.		Sie werden gelobt haben.

SUBJUNCTIVE MOOD.

	PRESENT.		PAST.
Sing.	Ich lobe, I may praise.	*Sing.*	Ich lobte, I might praise.
	Du lobeſt.		Du lobteſt.
	Er lobe.		Er lobte.
Plur.	Wir loben.	*Plur.*	Wir lobten.
	Ihr lobet.		Ihr lobtet.
	Sie loben.		Sie lobten.

	PRESENT PERFECT.		PLUPERFECT.
Sing.	Ich habe gelobt, I may have praised.	*Sing.*	Ich hätte gelobt, I might have praised.
	Du habeſt gelobt.		Du hätteſt gelobt.
	Er habe gelobt.		Er hätte gelobt.
Plur.	Wir haben gelobt.	*Plur.*	Wir hätten gelobt.
	Ihr habet gelobt.		Ihr hättet gelobt.
	Sie haben gelobt.		Sie hätten gelobt.

	FUTURE IMPERFECT.		FUTURE PERFECT.
Sing.	Ich werde loben, (if) I shall praise.	*Sing.*	Ich werde gelobt haben, (if) I shall have praised.
	Du werdeſt loben.		Du werdeſt gelobt haben.
	Er werde loben.		Er werde gelobt haben.

	FUTURE IMPERFECT.		FUTURE PERFECT.
Plur.	Wir werden loben.	*Plur.*	Wir werden gelobt haben.
	Ihr werdet loben.		Ihr werdet gelobt haben.
	Sie werden loben.		Sie werden gelobt haben.

CONDITIONAL MOOD.

	FUTURE IMPERFECT.		FUTURE PERFECT.
Sing.	Ich würde loben, I should praise.	*Sing.*	Ich würde gelobt haben, I should have praised.
	Du würdeſt loben.		Du würdeſt gelobt haben.
	Er würde loben.		Er würde gelobt haben.
Plur.	Wir würden loben.	*Plur.*	Wir würden gelobt haben.
	Ihr würdet loben.		Ihr würdet gelobt haben.
	Sie würden loben.		Sie würden gelobt haben.

IMPERATIVE MOOD.

PRESENT.

Sing. Lobe (du), praise thou.
Lobe er, let him praise.
Plur. Loben wir, let us praise.
Lobet (ihr), praise ye.
Loben ſie, let them praise.

INFINITIVE MOOD.

PRESENT.	PERFECT.	FUTURE.
Loben, to praise.	Gelobt haben, to have praised.	Loben werden, to be about to praise.

PARTICIPLE.

PRESENT.	PAST.
Lobend, praising.	Gelobt, praised.

THE MIXED CONJUGATION

(Embracing the Irregular Verbs properly so called).

There are a few verbs (sixteen in all) which have a sort of mixed conjugation, partaking of the Old Form, in that they change their radical vowels to form the past tense and the past participle, and at the same time partaking of the New Form, in that they assume, in the same parts, the ***tense-sign*** te and the participial ending -t. These are they which, strictly speaking, are the ***irregular*** verbs of the language, and accordingly they are here so classed. They will be found also in the general list of (so called) "irregular" verbs, which, for the sake of convenience, we have inserted.

PARADIGMS OF IRREGULAR VERBS.

In order to a better display of the irregularities of some of these verbs, we append the following paradigms. They will be found exceedingly convenient for ready reference. Some of these verbs also have certain peculiar uses which require special attention. For this reason we have, immediately after each verb, added a series of explanatory remarks, with copious examples illustrating the several ways in which they are employed.

Dürfen, *to be permitted, to dare.*

IND. *Pres.* Ich darf, du darfſt, er darf; wir dürfen, ihr dürft, ſie dürfen.—*Past.* Ich durfte, du durfteſt, er durfte; wir durften, ihr durftet, ſie durften.—*Pres. Perf.* Ich habe gedurft; wir haben gedurft.—*Plup.* Ich hatte gedurft; wir hatten gedurft.—*Fut. Imp.* Ich werde dürfen; wir werden dürfen.—*Fut. Perf.* Ich werde gedurft haben, wir werden gedurft haben.

VERBS OF THE MIXED CONJUGATION.

INFINITIVE.	INDICATIVE. *Present.*	INDICATIVE. *Past.*	SUBJUNCTIVE. *Past.*	PAST PARTICIPLE.	IMPERATIVE.
Brennen, to burn	*regular*	ich brannte	ich brennte	gebrannt	*regular*
Bringen, to bring	"	ich brachte	ich brächte	gebracht	"
Denken, to think	"	ich dachte	ich dächte	gedacht	"
Dürfen, to be permitted	ich darf, du darfſt, er darf	ich durfte	ich dürfte	gedurft	"
Haben, to have	ich habe, du haſt, er hat	ich hatte	ich hätte	gehabt	"
Kennen, to know	*regular*	ich kannte	ich kennte	gekannt	"
Können, to be able, can	ich kann, du kannſt, er kann	ich konnte	ich könnte	gekonnt	"
Mögen, to be allowed, may	ich mag, du magſt, er mag	ich mochte	ich möchte	gemocht	"
Müſſen, to be obliged, must	ich muß, du mußt, er muß	ich mußte	ich müßte	gemußt	"
Nennen, to name	*regular*	ich nannte	ich nennte	genannt	"
Rennen, to run	"	ich rannte	ich rennte	gerannt	"
Senden, to send	"	ich ſandte	ich ſendete	geſandt	"
Sollen, to be obliged, shall	ich ſoll, du ſollſt, er ſoll	*regular*	*regular*	*regul*	"
Wenden, to turn	*regular*	ich wandte	ich wendete	gewandt	"
Wiſſen, to know	ich weiß, du weißt, er weiß	ich wußte	ich wüßte	gewußt	"
Wollen, to be willing	ich will, du willſt, er will	*regular*	*regular*	*regular*	"

SUB. *Pres.* Ich dürfe, du dürfeſt, er dürfe; wir dürfen, ihr dürfet, ſie dürfen.—*Past.* Ich dürfte, du dürfteſt, er dürfte, wir dürften, ihr dürftet, ſie dürften.—*Pres. Perf.* Ich habe gedurft, wir haben gedurft.—*Plup.* Ich hätte gedurft, wir hätten gedurft.—*Fut. Imp.* Ich werde dürfen; wir werden dürfen. *Fut. Perf.* Ich werde gedurft haben, wir werden gedurft haben.

COND. *Fut Imp.* Ich würde dürfen, wir würden dürfen. —*Fut. Perf.* Ich würde gedurft haben; wir würden gedurft haben.

INF. *Pres.* Dürfen, to be permitted.—*Perf.* Gedurft haben, to have been permitted.

PART. *Pres.* Dürfend, being permitted.—*Past.* Gedurft, permitted

REMARKS ON Dürfen.—This verb is generally to be rendered by *to be permitted.* The verb is also employed (only in the past subjunctive, however) to denote what *probably may be*, and may then be translated by such words as *might*, *need*, *would*, etc.; thus·—Es dürfte jetzt zu ſpät ſein, it *may* (or *might*) *be* too late now; Es dürfte vielleicht wahr ſein, it *might* perchance *be* true. It also signifies *to need*, *to have occasion*, etc., as·—Er darf nur reden, he *needs* only speak; Er darf ſich darüber nicht wundern, he *must* not (or *should* not) wonder at that. When used without an infinitive after it, one must be supplied to complete the construction; thus:—Er darf nicht in das Haus (kommen), he is not allowed (to come) into the house.

Können, *to be able*.

IND. *Pres.* Ich kann, du kannſt, er kann; wir können, ihr könnt, ſie können.—*Past.* Ich konnte, du konnteſt, er konnte, wir konnten, ihr konntet, ſie konnten—*Pres. Perf.* Ich habe gekonnt, wir haben gekonnt.—*Plup.* Ich hatte gekonnt, wir hatten gekonnt.—*Fut. Imp.* Ich werde können; wir werden können—*Fut. Perf.* Ich werde gekonnt haben, wir werden gekonnt haben.

SUB. *Pres.* Ich könne, du könneſt, er könne; wir können, ihr könnet, ſie können.—*Past.* Ich könnte, du könnteſt, er könnte; wir könnten, ihr könntet, ſie könnten.—*Pres. Perf.* Ich habe gekonnt, wir haben gekonnt.—*Plup.* Ich hätte gekonnt; wir hätten gekonnt.—*Fut. Imp.* Ich werde können, wir werden können—*Fut. Perf.* Ich werde gekonnt haben; wir werden gekonnt haben.

COND. *Fut. Imp.* Ich würde können, wir würden können.—*Fut. Perf.* Ich würde gekonnt haben, wir würden gekonnt haben.

INF. *Pres.* Können, to be able.—*Perf.* Gekonnt haben, to have been able.

PART. *Pres.* Könnend, being able.—*Past.* Gekonnt, been able.

REMARKS ON Können—The original signification of können was *to know*, or *to know how*; hence the present sense, to be *at liberty* to do a thing, to be *able*, as:—Ich kann leſen und ſchreiben, I can (know how to) read and write. Its chief use now is to indicate bare possibility, and hence it is often aptly translated by the English *may*, as:—Er kann es verſtanden haben, he *may* (possibly) have understood it. It differs, therefore, from dürfen, when it (dürfen) is used (in the past subjunctive) to express possibility; for dürfen not only signifies that the thing *may* be, but that it *probably is* or *will* be. Können, like dürfen, has sometimes an infinitive understood after it, to complete the construction.

Mögen, *to be allowed*, *to have liberty*.

IND. *Pres.* Ich mag, du magſt, er mag; wir mögen, ihr mögt, ſie mögen—*Past.* Ich mochte, du mochteſt, er mochte; wir mochten, ihr mochtet, ſie mochten.—*Pres. Perf.* Ich habe gemocht, wir haben gemocht.—*Plup.* Ich hatte gemocht; wir hatten gemocht.—*Fut. Imp.* Ich werde mögen, wir werden mögen.—*Fut. Perf.* Ich werde gemocht haben; wir werden gemocht haben.

SUB. *Pres.* Ich möge, du mögeſt, er möge; wir mögen, ihr möget, ſie mögen—*Past.* Ich möchte, du möchteſt, er möchte wir mögen ihr möchtet, ſie möchten.—*Pres. Perf.* Ich habe gemocht; wir haben gemocht.—*Plup.* Ich hätte gemocht; wir hätten gemocht.—*Fut. Imp.* Ich werde mögen, wir werden mögen.—*Fut. Perf.* Ich werde gemocht haben; wir werden gemocht haben.

COND. *Fut. Imp.* Ich würde mögen; wir würden mögen.—*Fut. Perf.* Ich würde gemocht haben, wir würden gemocht haben.

INF. *Pres.* Mögen, to be allowed.—*Perf.* Gemocht haben, to have been allowed.

PART. *Pres.* Mögend, being allowed.—*Past.* Gemocht, allowed.

REMARKS ON Mögen.—Mögen marks *possibility* under allowance or concession from another, as:—Er mag lachen, he *may* laugh—that is, he has permission to laugh, no one hinders him; Er mag ein braver Mann ſein, he *may* (I grant) be a brave man—where the *possibility* of his being a brave man is a thing conceded. Kindred to this are the other significations (*chance*, *inclination*, *wish*, etc.) usually attributed to this verb; thus:—Es möchte regnen, it *might* rain—that is, the causes that seem to forbid are likely not to operate; Ich möchte es bezweifeln, I am *disposed* (or *inclined*) to doubt it—that is, *I might* doubt it altogether, but for certain circumstances seeming to forbid; Möge es der Himmel geben, *may* Heaven grant it; Ich mag es nicht thun, I do not *like* to do it—that is, I am not permitted by my feelings to do it cheerfully; etc.

Müſſen, *to be obliged*, *must*.

IND. *Pres.* Ich muß, du mußt, er muß; wir müſſen, ihr müßt, ſie müſſen.—*Past.* Ich mußte, du mußteſt, er mußte

wir mußten, ihr mußtet, ſie mußten.— *Pres. Perf.* Ich habe gemußt; wir haben gemußt.—*Plup.* Ich hatte gemußt, wir hatten gemußt.—*Fut. Imp.* Ich werde müſſen; wir werden müſſen.—*Fut. Perf.* Ich werde gemußt haben; wir werden gemußt haben.

SUB. *Pres.* Ich müſſe, du müſſeſt, er müſſe; wir müſſen, ihr müſſet, ſie müſſen.—*Past.* Ich müßte, du müßteſt, er müßte; wir müßten, ihr müßtet, ſie müßten.—*Pres. Perf.* Ich habe gemußt; wir haben gemußt.—*Plup.* Ich hätte gemußt; wir hätten gemußt.—*Fut. Imp.* Ich werde müſſen, wir werden müſſen.—*Fut. Perf.* Ich werde gemußt haben, wir werden gemußt haben.

COND. *Fut. Imp.* Ich würde müſſen; wir würden müſſen.—*Fut. Perf.* Ich würde gemußt haben, wir würden gemußt haben.

INF. *Pres.* Müſſen, to be obliged.—*Perf.* Gemußt haben, to have been obliged.

PART. *Pres.* Müſſend, being obliged. — *Past.* Gemußt, obliged.

REMARKS ON Müſſen.—The German müſſen and the English *must* are very nearly equivalents. The predominant sense of the word is everywhere that of *obligation* or *necessity*, and this being kept in mind, it will often be convenient to employ in translating it such words as *be obliged*, *am to*, *have need to*, and the like. Often an infinitive is understood with it, as:—Ich muß zurück, I must (go) back.

TRANSLATION FROM GERMAN.

Byron und Polidori.

Wie Lord Byron ſelbſt erzählt, fand folgendes Geſpräch zwiſchen ihm und Polidori, einem ſehr eiteln, italieniſchen Arzte während einer Rheinreiſe ſtatt. „Was konnen Sie denn thun, wozu ich nicht im Stande wäre?" fragte der Arzt „Da Sie mich drängen," antwortete der Dichter, „ſo will ich es Ihnen ſagen; ich glaube, es giebt drei ſolche Dinge." Polidori beſtand darauf daß er ſie nennen ſollte, und Lord Byron ſprach· „Ich kann über dieſen Strom ſchwimmen, ich kann ein Licht auf eine Entfernung von zwanzig Schritt mit einem Piſtolenſchuſſe ausblaſen, und ich habe ein Gedicht geſchrieben' von dem an einem Tage 14,000 Exemplare verkauft worden ſind."

KEY TO TRANSLATION FROM GERMAN
(Vol. VI, p. 372).

THE HUNGRY ARABIAN.

An Arabian had lost himself in the desert. Two days he had nothing to eat, and was in danger of dying of hunger, when he at last found one of the water-pits at which the travellers water their camels. Here he saw lying on the sand a little leather sack. "God be praised," said he, when he lifted it up and felt (it); "these are, I think, dates or nuts; how I will refresh and comfort myself with them." In this sweet hope he opened the sack, saw what it contained, and cried out, full of sadness, "Ah! they are only pearls."

COMPARATIVE ANATOMY.—V.

[*Continued from Vol. VI., p. 308.*]

VERMES (WORMS) (*continued*).

THIS creature belongs to the class *Platyhelminthes* or flat-worms, and in common with all belonging to its sub-class, that of the *Cestoda*, is entirely nourished by absorption, and for this reason we have taken the tapeworm as the type of an entozoon. (*See* Fig. 24.)

The animals of the sub-class *Trematoda* differ from these in having an alimentary canal channelled out in the substance of an otherwise solid body. The animal belonging to this sub-class with which we are unfortunately best acquainted is the liver-fluke, which occasions the disease called the *rot* in sheep (Fig. 24). This creature is found abundantly in the livers of sheep so affected. Sometimes as many as a thousand have been found in a single liver. The animal is of considerable size, measuring from ¾ to 1 inch in length, and about ½ inch in breadth. It is flat, and shaped like a little sole. Its anterior extremity is extended into a nipple-shaped projection, at the end of which is the sucker, which is perforated by the mouth of the animal. Another sucker of larger size is situated on the under side of the body, at about a quarter of an inch from the mouth. This is similarly constructed, but is imperforate, and does not communicate with any internal organ. Locomotion, so far as it is needed to this animal, is effected by these suckers, which can be alternately attached, and also by the general flexibility of the body, which has a muscular layer beneath the epidermis. The mouth leads down into a short gullet, below which the alimentary canal divides into two main trunks, which run down to the hinder end of the animal, giving off blind branches in a way best explained by the engraving. There is no anus, and this perhaps is not needed, on account of the highly organised food which the animal ingests. The fluke, however, readily ejects the food from its branched stomach by curling itself up like a little strip of heated parchment, and thus squeezing it out. Another system of vessels has a single opening towards the tail of the body, and runs forward, giving off branches on either side. This system corresponds with the water-vascular system of the *Tænia*.

This animal, like the tapeworm, is hermaphrodite, that is, it has both male and female organs. The development of these creatures is peculiar. When the matured eggs are voided from the sheep, a larva escapes, which swims about by cilia, and has a single)(-shaped eye. This larva fixes on the little fresh water snail which is known as *Lymnæus truncatulus*, and penetrates its skin, and when it has arrived at the interior, is transformed into a large bag or *nurse*, containing in its interior many elongated larvæ called *Rédiæ* (after the famous Italian Rédi); these produce internally either daughter Rédiæ or tadpole-shaped animals with long tails, called *Cercariæ*. These *Cercariæ* once more escape, not only from their foster-parent or nurse, but also from their molluscous host, into the surrounding fields, and it is probable that they are eaten with grass by sheep, and then penetrate to the liver, causing the rot. In accordance with these facts, some of which have been observed by Thomas and Leuckart in only recent years, it is found that sheep fed on dry land or on the great salt-water marshes are comparatively free from rot, while those fed up in fresh-water marshes are peculiarly subject to it. The disease associated with these creatures is of considerable economic importance, as in some years it has been reckoned that between one and two millions of sheep have died of the rot in Britain alone.

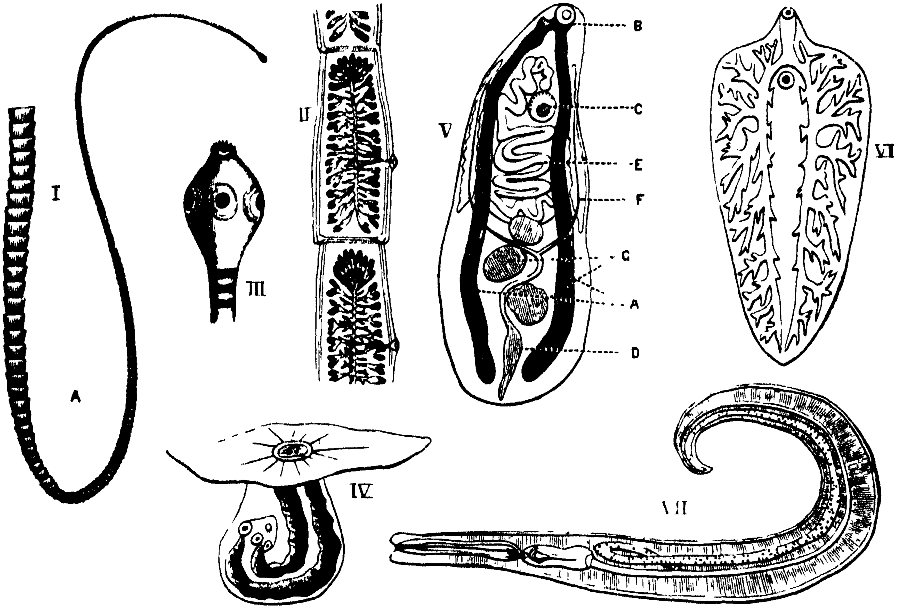

Fig. 24.—I. TÆNIA SOLIUM (CYSTICERCUS), NATURAL SIZE. II JOINTS ENLARGED TO SHOW REPRODUCTIVE ORGANS. III. HEAD ENLARGED TO SHOW THE SUCKERS AND HOOKS IV. HEAD OF THE LARVA PROJECTING INTO THE BLADDER-LIKE CYST. V. LIVER FLUKE (DISTOMUM HEPATICUM). VI. THE SAME, SHOWING THE BRANCHING ALIMENTARY CANAL AND THE TWO SUCKERS. VII. OXYURIS VERMICULARIS (MALE).

Refs. to letters in Fig. V.—A, double alimentary canal; B, mouth sucker; C, ventral sucker, D, water-vascular system; E, female organ; F, glands which form the egg-yolk, G, male organs.

Besides the flukes there is another class of parasitic worms called *Nematohelminthes*, or thread worms. They have alimentary canals of the same type as the higher animals, being tubes within tubes. These creatures are not hermaphrodite, but the individuals are male or female. Some of these animals are not parasitic at all, and some of them only under certain circumstances. Thus, there is found in the tropical regions of Asia and Africa an intolerable pest, called the *Dracunculus Medinensis*. This troublesome parasite is always the female, and it gains access to the body from water through the skin, and then grows and emits its brood, to the great annoyance of its host, often occasioning death. When it reaches its full size it is some feet in length, though only $\frac{1}{16}$ of an inch in thickness. It will migrate beneath the skin from one part of the body to another. Some have supposed that these animals were the fiery serpents which attacked the Israelites in the wilderness. The only remedy seems to be to cut down to the worm, and having got hold of one end, to wind it round a piece of stick. When thus secured, the stick is left for a day or two, and then more of the worm's body is drawn out, and a further winding takes place, and so on until the whole is extracted entire.

The classes which contain the parasitic worms may be thus divided:—

I. **Platyhelminthes**
  1. Turbellaria non-parasitic.
  2. Trematoda = flukes.
  3. Cestoda = tapeworm.

II **Nematohelminthes** 4. = round worms.

III **Acanthocephala** 5. = thornheaded worm.

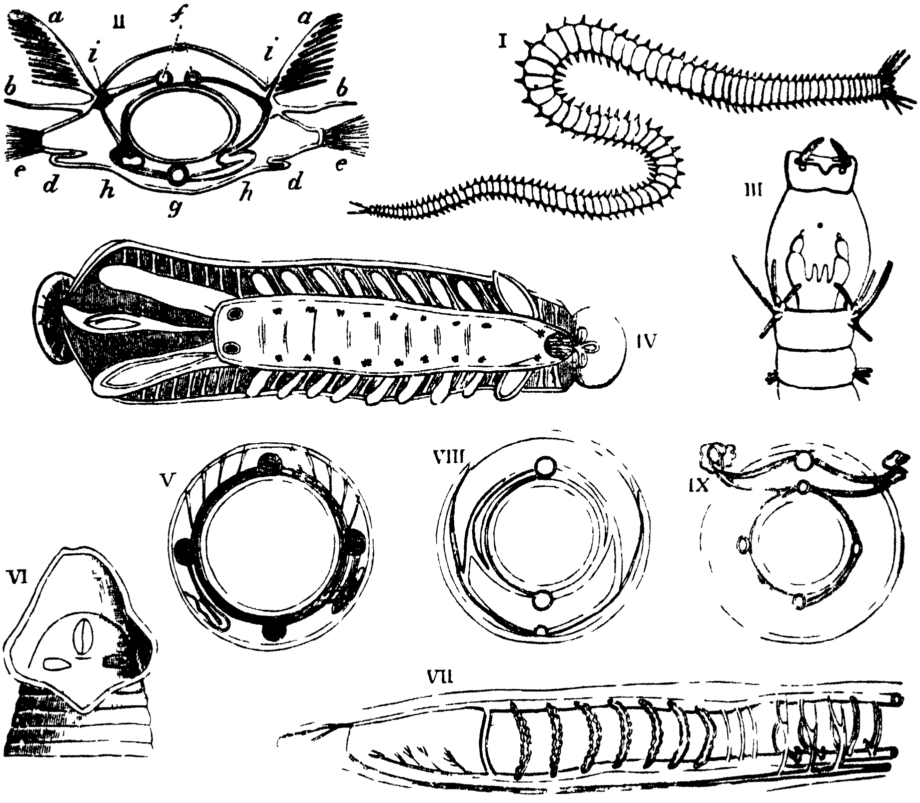

Fig. 25.—I. Nereis (a Sea worm). II. Transverse Section of the Eunice. III. Proboscis of a Nearly Allied [illegible] IV. Leech, showing the Body wall and Alimentary Canal laid open along the Back. V. Diagram showing the Circulation in the Leech. VI. Oral Sucker of a Leech. VII. Longitudinal Section of an Earth-worm, showing the Circulation. VIII. Diagram showing the Circulation in a Transverse Section of a Worm at the Tail End of the Animal. IX. Diagram showing the Transverse Circulation in a Lob-worm (Arenicola).

Refs. to Nos. in Fig. II.—*a*, comb-like gill; *b*, dorsal feelers; *c*, bundles of bristles; *d*, ventral feelers; *e*, cavity of alimentary canal; *f*, dorso intestinal vessels; *g*, ventral vessel; *h*, vascular loop acting as a heart to force the blood to the gills; *i*, plexus of vessels beneath the gills.

ANNULATA: RINGED WORMS.

We have now arrived at a class in the animal kingdom in which the radial symmetry is almost entirely abandoned, and the two-sided arrangement is perfect. In accordance with this advance we find many of these animals gifted with considerable powers of locomotion, and it is in this class that we first find animals which have adopted a quasi-aërial mode of life. Nature, we are told by the ancients, and told truly, does nothing suddenly, and hence, though the arrangement best adapted to rapid locomotion is found in this class, and some of these animals reside in that thin medium through which the body can be impelled with the greatest velocity, yet the means of locomotion in this class are but feeble. The instruments of locomotion, the limbs, are but rudimentary; and though the earth-worm be capable of breathing in air, it respires on the aquatic type, and, indeed, requires that its skin be kept moist to respire at all. Hence, the earth-worm always inhabits *moist* earth, and makes its peregrinations above the soil after dark, when the sun's rays, which would rapidly dry it up, are directed elsewhere, or if it appear during the day it is only when air and soil are both damp with rain. (Fig. 25).

This class also introduces us to the jointed type of animals under its simplest form. In these worms we see the beginnings of all the more complicated organs which we find in the lobster and the bee, but they are in a very incomplete condition. In accordance with what we have said about the characteristics of an animal of a low grade of structure, we find the *vegetative repetition of parts* here manifested in a high degree. The same parts are repeated over and over again, sometimes to the number of hundreds. In fact, the bodies of these animals may be said to consist of a long series of exactly similar rings or segments placed one behind the other, and containing all the parts essential to life in each segment. Thus the earth-worm has a mouth developed in the under side of the first segment, and an opening in the tail segment for the completion of the alimentary canal; but all the intermediate segments form a series differing from one another only in size. Each segment has its own ring-like outer wall, its own nervous centre, its compartment of the stomach, its transverse circulatory organs, and its so-called nephridia (or renal organs). In some of the water-worms the presence of feelers, proboscis, and jaws in the fore part—or of localised gills, etc., in the after parts—of the body, somewhat interferes with this repetition.

We have said that each segment has its own nervous centre, a centre consisting of two nerve knots, situated on the under side or floor of the segment, and sending lateral nervous threads to its own special ring. It is, however, essential to individual life that the whole of the nervous system should be united, and therefore, to effect this, two cords run from the two nerve-centres of each segment to each of the adjoining segments before and behind it. This arrangement gives rise to a double beaded or knotted cord of nervous matter stretching along the floor of the body-cavity from end to end. Since the mouth always opens on the under side of the body, and the organs of sense, when present, are necessarily placed in the neighbourhood of this and in the front of the animal, it follows that the nervous centre, which supplies these organs with nerves (the necessary carriers of sensation), must be situated above the throat, and must also be joined to the next centre lying under the throat by two cords, one of which runs on each side of the gullet; otherwise symmetry would not be maintained.

In the symmetry of the nervous system, and in the segmental condition of their bodies, the worms are like the higher classes of the Articulata, which are represented by the insects, crustaceans, and others. They differ from these in having no definitely jointed limbs, in having a system of blood-vessels completely shut off from the body-cavity, whose whole circuit is perfect, and in having ciliated membranes at some period of their lives in some parts of their bodies. Besides these distinctive characters there is another very generally possessed by worms, and that is that the exterior of their bodies, instead of being stiff and hard, is soft and flexible. The body-wall is composed, not of a horny substance called chitine, as is the case in insects; but of a covering membrane, beneath which muscular fibres are placed. Since there are no jointed levers for limbs, it follows that the whole movement of the body must depend on the flexibility, contractility, and elasticity of the integument, and hence the soft character of the outer integument is a matter of necessity.

The species which stands as the representative of the whole of this class, both on account of its widespread occurrence, and of the multitude of individuals of which it is composed, is the common earth-worm (*Lumbricus terrestris*). Nevertheless, this is rather an aberrant species of the class than its proper type. Its residence in moist earth has imposed upon it a different means of locomotion, and also of respiration, from the more typical examples of the Annulata. The proper type of the class is rather found among those sea-worms which fishermen find in the sand at low tide and use as baits for fish, and to which the names of lob-worm and lug-worm are applied somewhat indiscriminately. One of these is the Nereis, represented in the engraving. This worm consists of a great many segments; unlike the earth-worm the head is very distinct, and is furnished both with antennæ or feelers, and eyes, though the latter are of very simple structure. The orifice of the mouth opens on the under side of the body. The worm appears in its ordinary condition to be a very innocent, inoffensive, and defenceless animal, like the ordinary earth-worm; but this appearance is deceptive, and only arises from the fact that the powerful jaws are concealed. If the animal be handled while alive, it will suddenly evert and protrude a formidable proboscis armed with a large pair of horny jaws, and with these it will attack the fingers of its captor. The proboscis while at rest is retracted in the same manner as the finger of a glove might be withdrawn by pulling the end in from the inside. These retractile trunks are very general throughout the families of the free-moving sea-worms, and though in the Nereis (Fig. 25) the proboscis is only armed with one pair of jaws, in some it has seven, eight, or nine jaws. Besides these jaws which play laterally, other instruments are sometimes attached to the trunk. One species has a circlet of cartilaginous beads round its proboscis, and another has a number of horny plates so arranged as to form a file. Among the tube-dwellers, the trunk is quite unarmed, and must act as a flexible lip to suck in substances.

With regard to the remainder of the segments behind the head and proboscis, they are almost exactly alike, the external appendages being locomotive organs and more or less developed gills.

In the case of the Nereis, the gills are not well developed, but consist of slightly protruded thin membranes where the breathing function is localised; but in nearly allied forms, these gills are developed into branched bundles of vessels, or into plates or leaves, into the substance of which the blood enters, and becomes exposed to the influence of the surrounding water through their very thin walls. It is sufficient to say that the gills or tufts of respiratory vessels are, when present, always protruded from the back or upper side of the animal, and are sometimes not developed in every segment, but confined to certain regions of the elongated body. So in the common lob-worm (*Arenicola*) they are limited to the sixteen middle segments of the body. The locomotive organs which are most effective are bundles of hairs or bristles which stand at the ends of protrusions from the body wall, and which can be more or less retracted into the flexible papillæ which bear them. These bundles of bristles are always paired, and sometimes there are two pairs on each segment. They are brush-like oars, which the animal plies with such regularity one after the other in succession, that the general effect produced to the eye is as of a series of waves following one another from head to tail. Hence the simile often applied to these animals of a galley with its bank of oars, or of an elongated cutter with a multitude instead of eight oars, is hardly a good one, since the oars of these all play in unison, while the brushes of the sea-worm play successively. Nevertheless, the remarkable order which the simile suggests is well maintained. These organs are, of course, very different from the jointed limbs of the Arthropoda, and cannot be applied to points of resistance with the same definiteness and accuracy. Yet they are not ill suited to the wants of the animals, for these are always found among the sand and mud of the bottom of the sea, and their limbs are equally effective against water, mud, or sand. Besides the bunches of bristles, there are fleshy appendages called cirri; the relation of these to one another is well seen in the ventral feelers shown in the section of a segment of the body of the Eunice.

The food canal of these animals runs in a straight or slightly flexuous course from head to tail. There is sometimes a muscular gizzard, and generally the tube is more or less sacculated—that is, it consists of alternate enlargements and constrictions, the enlargements usually corresponding to one or more of the outer rings of the body. From the outer wall to the constrictions run partitions which divide the body cavity into a number of chambers. These partitions are not complete, but are perforated so as to allow of the passage of the fluid of the cavity. In some the body cavity, or space between the food canal and outer skin, is large; in the leech it is filled up, so that the same network of vessels which runs round the stomach, and sucks and absorbs the alimentary liquids into the blood, also supplies the integument with blood, and there exposes it to the influences of the air.

From the foregoing sentences the intelligent reader will have gathered that in the Annulata there are two distinct vital fluids which are shut off from one another:—

1. The fluid which occupies all the space between the food tube and the body-wall, which is of watery consistence and pale colour, though containing albumen and corpuscles.

2. The fluid contained in the blood-vessels, which has usually no corpuscles, and is of a dark red or green colour.

In the Eunice (Fig. 25), which may be taken as a type of the circulation in those worms with a distinct body cavity, the arrangement of the vascular system and the course of its contents are as follow:—Two main vessels run along the upper side of the intestine, and receive the blood and the fluids added from the aliment from the network of vessels which invests that tube. At the point where the dilated throat joins the intestinal tube a large vessel runs round the alimentary tube, while the two vessels before named are united into one large contractile vessel, and thus continued forward towards the head. The large single vessel does not adhere to the throat or pharynx, but acts as a heart to propel the blood received, not only from the intestine, but also from a vessel which runs along the integument of the back. The blood thus derived from the system, both alimentary and intestinal, is forced by branches to the head and also round into a vessel which runs along the floor of the body. This ventral vessel, as it is called, gives off at each segment a lateral branch on each side, which is bent into a loop, which acts as a special heart to drive the blood to the network of vessels lying under each tuft-like gill. After being aërated in the gills the blood is returned to the main dorsal vessel by ducts, which are sustained by the partitions which join the body wall to the intestinal wall. In the case of the lob-worm (*Arenicola*) the gills are supplied from vessels which branch off from the main trunk, running along the top of the intestine, and they return the blood to the great dorsal vessel, which is situated in the mid-line of the integument. The gills of this creature are beautiful objects under the microscope, although they appear to be but confused tufts of vessels to the naked eye. Although these tufts of vessels are so very delicate that the blood shines through them—and as indeed it is necessary they should be for the function of respiration to be accomplished—yet they have voluntary muscular fibres running round them. This is manifest, not only from the revelation of the microscope; but also from the fact that the animal can empty and retract any or all of its gills at pleasure. In this case the gills are little else than tufts of vessels derived exclusively from the closed vascular circuit; but in those cases before alluded to, where the gills are more like solid plates, not only is the fluid of the vessels conveyed into them; but they are channelled into spaces into which the fluid of the body cavity can find its way, and thus becomes exposed to the influence of the oxygen of the water.

When the gills are almost wholly composed of protrusions of the vascular system through the body wall, since the blood in them is kept in constant and rapid circulation, it is necessary that the outer sea-water should be as rapidly changed; and hence we find such gills are clothed with those minute, constantly moving hairs which we call cilia. On the other hand, when the gills are in the shape of massive lobes so channelled out as to admit of the fluid of the body cavity remaining in them, and being changed slowly by the motion of the body, the necessity of change of the external water is not so pressing, and therefore these lobes are naked and not ciliated.

LATIN.—XXXVII.

[*Continued from Vol. VI., p. 380.*]

THE AGRICOLA OF TACITUS (*continued*).

The Death of Agricola.

43. Finis vitae eius nobis luctuosus, amicis tristis, extraneis etiam ignotisque non sine cura fuit. Vulgus quoque et hic aliud agens populus et ventitavere ad domum et per fora et circulos locuti sunt; nec quisquam audita morte Agricolae aut laetatus est aut statim oblitus. Augebat miserationem constans rumor veneno interceptum: nobis nihil comperti adfirmare ausim. Ceterum per omnem valetudinem eius crebrius quam ex more principatus per nuntios visentis, et libertorum primi et medicorum intimi venere, sive cura illud sive inquisitio erat. Supremo quidem die momenta ipsa deficientis per dispositos cursores nuntiata constabat, nullo credente sic adcelerari quae tristis audiret. Speciem tamen doloris habitu vultuque prae se tulit, securus iam odii et qui facilius dissimularet gaudium quam metum. Satis constabat lecto testamento Agricolae, quo coheredem optimae uxori et piissimae filiae Domitianum scripsit, laetatum eum velut honore iudicioque. Tam caeca et corrupta mens assiduis adulationibus erat, ut nesciret a bono patre non scribi heredem nisi malum principem.

His Age and Character.

44. Natus erat Agricola Gaio Caesare tertium consule idibus Juniis: excessit sexto et quinquagesimo anno, decumo kalendas Septembris Collega Priscoque consulibus. Quod si habitum quoque eius posteri noscere velint, decentior quam sublimior fuit; nihil metus in vultu: gratia oris supererat. Bonum virum facile crederes, magnum libenter. Et ipse quidem, quamquam medio in spatio integrae aetatis ereptus, quantum ad gloriam, longissimum aevum peregit. Quippe et vera bona, quae in virtutibus sita sunt, impleverat, et consulari ac triumphalibus ornamentis praedito quid aliud adstruere fortuna poterat? Opibus nimiis non gaudebat, speciosae contigerant. Filia atque uxore superstitibus potest videri etiam beatus incolumi dignitate, florente fama, salvis adfinitatibus et amicitiis futura effugisse. Nam sicut ei non licuit durare in hanc beatissimi saeculi lucem ac principem Trajanum videre, quod augurio votisque apud nostras auris ominabatur, ita festinatae mortis grande solacium tulit evasisse postremum illud tempus, quo Domitianus non jam per intervalla ac spiramenta temporum, sed continuo et velut uno ictu rem publicam exhausit.

45. Non vidit Agricola obsessam curiam et clausum armis senatum et eadem strage tot consularium caedes, tot nobilissimarum feminarum exilia et fugas. Una adhuc victoria Carus Metius censebatur, et intra Albanam arcem sententia Messalini strepebat, et Massa Baebius tum reus erat: mox nostrae duxere Helvidium in carcerem manus; nos Maurici Rusticique visus, nos innocenti sanguine Senecio perfudit. Nero tamen subtraxit oculos suos jussitque scelera, non spectavit: praecipua sub Domitiano miseriarum pars erat videre et aspici, cum suspiria nostra subscriberentur, cum denotandis tot hominum palloribus sufficeret saevus ille vultus et rubor, quo se contra pudorem muniebat.

Tu vero felix, Agricola, non vitae tantum claritate, sed etiam opportunitate mortis. Ut perhibent qui interfuerunt novissimis sermonibus tuis, constans et libens fatum excepisti, tamquam pro virili portione innocentiam principi donares. Sed mihi filiaeque ejus praeter acerbitatem parentis erepti auget maestitiam, quod adsidere valetudini, fovere deficientem, satiari vultu complexuque, non contigit. Excepissemus certe mandata vocesque, quas penitus animo figeremus. Noster hic dolor, nostrum vulnus, nobis tam longae absentiae condicione ante quadriennium amissus est. Omnia sine dubio, optime parentum, adsidente amantissima uxore superfuere honori tuo: paucioribus tamen lacrimis comploratus es, et novissima in luce desideravere aliquid oculi tui.

46. Si quis piorum manibus locus, si, ut sapientibus placet, non cum corpore extinguuntur magnae animae, placide quiescas, nosque domum tuam ab infirmo desiderio et muliebribus lamentis ad contemplationem virtutum tuarum voces, quas neque lugeri neque plangi fas est. Admiratione te potius quam temporalibus laudibus et, si natura suppeditet, similitudine colamus: is verus honos, ea conjunctissimi cuiusque pietas. Id filiae quoque uxorique praeceperim, sic patris, sic mariti memoriam venerari, ut omnia facta dictaque eius secum revolvant, formamque ac figuram animi magis quam corporis complectantur, non quia intercedendum putem imaginibus quae marmore aut aere finguntur, sed, ut vultus hominum, ita simulacra vultus imbecilla ac mortalia sunt, forma mentis aeterna, quam tenere et exprimere non per alienam materiam et artem, sed tuis ipse moribus possis. Quidquid ex Agricola amavimus, quidquid mirati sumus, manet mansurumque est in animis hominum, in aeternitate temporum, in fama rerum; nam multos veterum velut inglorios et ignobilis oblivio obruit: Agricola posteritati narratus et traditus superstes erit.

NOTES TO TACITUS (*continued*).

Chap. XLIII.—*Extraneis.* As we might say in slang, "outsiders." In this place, however, the word "strangers" should be used.

Vulgus. Those who in the most modern terminology would be called "the masses."

Constans rumor. "A persistent rumour."

Nobis . . . . ausim. The construction of this passage is not clear, and the commentators have suggested emendations. If we retain the ordinary reading, we must translate, "I would not venture to assert that we ascertained anything."

Valetudinem. A bad state of health, *i.e.*, "illness."

Per nuntios visentis. "Which pays visits by messengers."

Dispositos cursores. "Messengers stationed at intervals."

Prae se tulit, *i.e.*, the Emperor.

Securus jam odio. "At last free of his hatred."

Velut honore judicioque. "As though the choice conferred honour upon himself."

Tam caeca et corrupta, etc. Domitian was so blinded by flattery that he did not see that a good citizen's object in leaving an Emperor money was to ensure the rest of his property to his relatives. An Emperor who was not thus remembered might lay hands upon the whole.

Chap. XLIV.—*Decentior quam sublimior.* "Well-proportioned rather than tall."

Nihil metus. "Nothing to inspire alarm."

Impleverat. "He had enjoyed to the full."

Speciosae contigerunt. This means that though he was not excessively wealthy, he had riches enough to keep up an appearance of dignity.

Adfinitatibus et amicitiis "His kinsfolk and friends," abstract used for concrete.

Nam sicut ei non licuit. This passage is corrupt and the editions vary. The reading adopted here gives the simplest sense, but it must be pointed out that it is conjectural.

Spiramenta temporum. "Breathing spaces."

Rem publicam exhausit. "He drained the blood of the State."

Chap. XLV.—*Consularium caedes.* Among the men of consular rank whom Domitian foully murdered were Civica Cerialis (mentioned in a previous chapter), Sallustius Lucullus, and Helvidius. Of the women of noble birth whom he drove into exile, the most distinguished was Arria, the wife of Thrasea.

Carus Metius was a famous informer, but when Agricola died his perfidy had only had one victim.

Messalinus was one of the worst of Domitian's tools. He was blind and shameless enough to do the Emperor's bidding in all things.

Massa Baebius is best known as the plunderer and oppressor of the Baltic province. He was tried for his oppression and condemned.

Albanam arcem. Domitian had a house near the Alban Mount, and Tacitus' meaning is that at first Messalinus had no influence outside the Emperor's own gates.

Perfudit. The verb *perfudit*, which is appositely used with *innocenti sanguine*, does not assort well with *visus*, which in one clause is its nominative. But another and a more suitable verb, such as *afflixit*, must be inferred. This figure of speech the grammarians called *zeugma*.

Subscribentur. "Were set down against us."

Novissimis sermonibus tuis. "Thy last words."

Tamquam pro virili portione. "As though doing all a man can do."

Chap. XLVI.—This chapter is one of the finest and most dignified passages in the whole of Latin literature.

Quam temporalibus. Some editions read *et immortalibus.* But the reading adopted here better suits the occasion and the context.

Similitudine. "With our imitation."

Si natura suppeditet. "If our nature is strong enough."

Per alienam materiam et artem. "In a foreign material and by means of art."

LATIN READINGS.

Our space will not permit us to give you in anything like a complete form the work of other Latin writers. But that you may be able to form some notion of their style and matter, we shall conclude by giving you brief specimens of the greatest among them. We shall now only provide you with translations of a few passages. The others you should be able to understand without assistance.

SALLUST.

Caius Crispus Sallustius, the Roman historian, was born B.C. 86, and was a contemporary of Cæsar and the orator Cicero. At a comparatively early period of his life he began to take a prominent part in the political affairs of Rome, and filled several of the highest offices in the state; but having amassed a considerable fortune in the province of Numidia, whither he had been sent as governor, he retired from public life, and having spent the remainder of his days in luxurious ease, he died B.C. 34.

The works of Sallust which have come down to us are two historical pieces, or monographs, as they are called—that is, narratives of a separate series of connected events—one on the conspiracy of Catiline, the other on the war with Jugurtha. He is also said to have written a more complete contemporary history of Rome, in five books, of which some extracts and detached sentences are all that remain to us.

Sallust is the first Roman author who cultivated in his writings an elaborate and self-conscious style. His diction is by no means obscure; but he delights in strong antitheses and short, nervous sentences; he also makes a frequent use of the historical infinitive in his descriptions. He affected ancient forms and methods of spelling.

The "Catilina," from which our first extracts are taken, is an account of a conspiracy against the government of Rome by Lucius Sergius Catilina, a profligate noble of broken fortunes, who, supported by a body of followers in similar circumstances, discontented and turbulent like himself, hoped to recruit his fortunes out of the general state of anarchy and disorder which it was his object to create. The character of the man is vigorously drawn by Sallust in the following lines:—

SALLUST.—"CATILINA," V.

Lucius Catilina, nobili genere natus, fuit magnâ vi et animi et corporis, sed ingenio malo pravoque. Huic ab adolescentia bella intestina, caedes, rapinae, discordia civilis, grata fuere; ibique juventutem suam exercuit. Corpus patiens inediae, vigiliae, supra quam cuiquam credibile est: animus audax, subdolus, varius, cujus rei libet simulator ac dissimulator; alieni appetens, sui profusus; ardens in cupiditatibus; satis eloquentiae, sapientiae parum. Vastus animus immoderata, incredibilia, nimis alta semper cupiebat. Hunc post dominationem Lucii Sullae lubido maxima invaserat reipublicae capiendae; neque id quibus modis assequeretur, dum sibi regnum pararet, quidquam pensi habebat. Agitabatur magis magisque in dies animus ferox, inopia rei familiaris, et conscientia scelerum; quae utraque his artibus auxerat quas supra memoravi. Incitabant praeterea corrupti civitatis mores, quos pessima ac diversa inter se mala, luxuria atque avaritia, vexabant.

NOTES.

Nobili genere, "a distinguished family." Several members of the *gens Sergia*, to which Catilina belonged, had made themselves famous in former years, and the family claimed descent from the Trojan hero, Sergestus, who was said to have come into Italy with Æneas. (*See* Vergil, "Æneid," v. 121: *Sergestusque, domus tenet a quo Sergia nomen.*)

Vi—ingenio, a descriptive ablative. "The ablative of a substantive, combined with an adjective, is subjoined to a substantive [Catilina] by way of description, either immediately or with the verb *esse* [as here], to denote the quality or character of a person or thing." (Madvig, "Latin Grammar.")

Pravo, "crooked, distorted," as distinguished from *malo*, which means bad in its essence.

Bella intestina, caedes, etc. The way these different substantives are thrown together without any connecting particles is a characteristic of Sallust's style.

Ibique, "and in them"; *sc.*, *iis rebus*, the wars and broils just mentioned.

Corpus (supply *fuit ei*), "he had a constitution," etc.

Cujus rei libet; sc., *cujuslibet rei*. Sallust is fond of thus separating the words. So in another passage we find *cujus rei cunque*, for *cujuscunque rei*.

Simulator, dissimulator. *Simulo* is to pretend that a thing is what it is not; *dissimulo*, to pretend that a thing is not what it is, so to conceal. The difference between the two is given in the line—

Quod non es simulas, dissimulasque quod es.

Satis—parum are both used as (lit.) substantives. *Satis (fuit ei) eloquentiae*, "he had a sufficiency of eloquence," "he was fairly eloquent."

Vastus, "empty, desert, waste," and so "monstrous, shocking."

Lucii Sullae. Sulla, as supreme dictator, gained almost absolute power in Rome after the overthrow of his rival, Caius Marius, B.C. 82.

Maxima, "more than any other man has felt."

Dum pararet, "so long as he was preparing."

Quidquam pensi habebat, "did not care at all." *Pensus*, from *pendo*, to weigh, signifies "prized, esteemed, valued." *Pensi* is the genitive of price; so in the "Jugurtha," chap. xli., *Neque pensi neque sancti habere*, "to hold neither as esteemed nor holy."

Inopia rei familiaris, "want of property."

Artibus, *sc.*, the evil courses he had taken to. The "*bella, caedes*," etc., in which "*juventutem suam exercuit.*"

Diversa inter se, "contrary one to the other."

The plot was fortunately discovered, mainly by the vigilance of the orator Cicero, who was one of the consuls at the time. Catilina fled the city, and put himself at the head of an army he had raised. An army under Petreius was sent against him, and the final blow was dealt to the plot by the death of Catilina in the battle described in the following extract:—

SALLUST.—" CATILINA," lx.

Sed ubi, omnibus rebus exploratis, Petreius tuba signum dat, cohortes paullatim incedere jubet: idem facit hostium exercitus. Postquam eo ventum est unde a ferentariis proelium committi posset maximo clamore cum infestis signis concurrunt; pila omittunt; gladiis res agitur. Veterani, pristinae virtutis memores, comminus acriter instare: illi haud timidi resistunt: maxima vi certatur. Interea Catilina cum expeditis in primâ acie versari, laborantibus succurrere, integros pro sauciis accersere, omnia providere, multum ipse pugnare, saepe hostem ferire; strenui militis et boni imperatoris officia simul exsequebatur. Petreius ubi videt Catilinam, contra ac ratus erat, magna vi tendere cohortem praetoriam in medios hostes inducit; eosque perturbatos atque alios alibi resistentes interficit, deinde utrimque ex lateribus adgreditur. Manlius et Faesulanus in primis pugnantes cadunt. Postquam fusas copias seque cum paucis relictum videt Catilina, memor generis atque pristinae dignitatis in confertissimos hostes incurrit, ibique pugnans confoditur.

NOTES.

Hostium exercitus, the army of the conspirators with Catilina at their head.

Ventum est unde (supply *in locum*), "when they had come to a place whence."

Ferentarii (der. *fero*), "light troops who fought with missile weapons."

Clamore, the ablative of manner. "The ablative of a substantive, in connection with an adjective, denotes the accompanying circumstances under which a thing is done. Sometimes the preposition *cum* is added." (Madvig, "Latin Grammar.")

Infestis, "hostile." So "opposing" of Cæsar ("Bello Gallico," vii. 51), *legiones infestis signis constiterunt.*

Concurrunt—pila omittunt. The short disjointed sentences are characteristic of the writer's style, and add force and vividness to the description.

Instare, the historical infinitive. Also a favourite construction with Sallust, as noted above. A few lines below we find a number of them. "The present infinitive is often used in the description of actions and emotions that follow in rapid succession." (Madvig.)

Illi, "the other party"; *sc.* "the enemy." Of two things, *ille* always refers to the more remote.

Expeditis, literally "unimpeded, disengaged"; and so "light-armed troops."

Contra ac, "differently from what he had thought he would." *Ac*, or *atque*, is found in the same way after *secus*, *alius*, etc.

Magna vi tendere, "exerting himself vigorously."

Cohortem praetoriam. The picked body-guard attached to the general was so called.

Alios alibi, "some in one direction, some in another"

In primis: either "are among the first to fall," or, "fall fighting among the foremost."

Confertissimos, "the part where the enemy's ranks"—that is, the army of the republic—"were thickest."

The "Jugurtha," from which our next extract is taken, is an account of a war waged against a Numidian prince of that name, who had endeavoured by treachery to seize the possessions of his kinsmen, to whom the Roman people had been appointed protectors. The extract describes an episode in the war, part of an engagement between the troops commanded by Jugurtha and Bomilcar, and the Roman army under Metellus:—

SALLUST.—" JUGURTHA," lii.

Eo modo inter se duo imperatores, summi viri certabant: ipsi pares, ceterum opibus disparibus. Nam Metello virtus militum erat, locus adversus; Jugurthae alia omnia, praeter milites opportuna. Denique Romani, ubi intelligunt neque sibi perfugium esse, neque ab hoste copiam pugnandi fieri, et jam die vesper erat; adverso colle, sicuti praeceptum fuerat, evadunt. Amisso loco, Numidae fusi fugatique, pauci interiere; plerosque velocitas et regio hostibus ignara tutata sunt. Interea Bomilcar, quem elephantis et parti copiarum pedestrium praefectum ab Jugurtha supra diximus, ubi eum Rutilius praetergressus est, paullatim suos in aequum locum deducit; ac dum legatus ad flumen, quo praemissus erat, festinans pergit quietus, uti res postulabat, aciem exornat; nequere mittit, quod ubique hostis ageret, explorare. Postquam Rutilium consedisse jam, et animo vacuum, accepit, simulque ex Jugurthae proelio clamorem augeri; veritus ne legatus, cognitâ re, foret, aciem, quam, diffidens virtuti militum, arcte statuerat, quo hostium itineri obficeret, latius porrigit.

NOTES.

Opibus, either a descriptive ablative, or an ablative absolute

Opportuna (*ob portus*), "opposite the harbour," and so, "convenient."

Die is the old form of the genitive *diei*, "the evening of the day."

Adverso colle, ablative of place.

Quod ubique. Supply *hostis ageret* with both of these. "What the enemy was doing, and where he was doing it."

Animo vacuum, "freed from anxiety." *Vacuum* governing an ablative, as if equivalent to the participle of a verb signifying deficiency, which, according to the regular rule, would take an ablative.

Proelio, the part of the field where Jugurtha was.

Suis auxilio, double dative.

Arcte, "in close array."

KEY TO TACITUS (*continued*).

37. Now those of the Britons who were lodged upon the ridges of the hills and had hitherto no share in the encounter, were calmly despising the smallness of our forces, and began to descend softly and to surround them in the rear, whilst they were urging their victory, when Agricola, who had apprehended this very design, despatched to engage them four squadrons of horse, such as he had reserved for the emergencies of war. The more furiously they had advanced, the more keenly were

they repulsed. Thus against the Britons themselves their own devices were turned; and by the order of the general, the squadrons of cavalry which charged in front, wheeled about and assailed the enemy behind. Then in truth, the open field presented a spectacle prodigious and tragical, incessant pursuits, wounds and captivity, and the present captives always slaughtered, as often as others occurred to be taken. Now the enemy behaved just as they happened to be prompted by their several humours. Sometimes they fled in large troops with all their arms before a smaller number that pursued them; others, unarmed, rushed into peril, and presented themselves to instant death. On all sides lay scattered arms and carcases, and mangled limbs, and the ground was dyed with blood. Nay, now and then even by the vanquished was exerted notable wrath and bravery. When once they drew near the woods they rallied, and thus circumvented the foremost pursuers, such as, without knowing the country, had rashly ventured too far. We must have suffered some notable disaster from excess of confidence, had not Agricola, who was assiduously visiting every quarter, ordered the stoutest cohorts lightly equipped to range themselves like a party of huntsmen, also some of the cavalry to dismount, and enter the straiter passes, and the rest of the horse, at the same time, to beat the more open and passable parts of the woods. Now, as soon as they perceived our forces to continue the pursuit with close ranks, they betook themselves to open flight, not in marching order as before, no one man regarding or awaiting another, but scattered, and avoiding each other, they all made to places far remote and desert. What ended the pursuit was night and a satiety of slaughter. Of the enemy were slain ten thousand There fell of our men three hundred and forty, amongst these Aulus Atticus, commander of a cohort, whose youthful heart and fiery horse hurried him into the midst of the enemies.

38. It was indeed a night of great joy to the conquerors, both from victory and spoil. The Britons, who wandered amid the dismal wailings of men and women, dragged along their wounded, called to such as were unhurt, deserted their houses, nay, in rage even set them on fire; made choice of lurking holes, then instantly forsook them. In turn they took counsel together, then each thought for himself. sometimes, at the sight of those dearest to them they were cast down, oftener excited to fury. Nay, it was certain that some murdered their children and wives, as an act of compassion and tenderness. The next day revealed more fully the result of the victory; on all sides a profound silence, solitary hills, houses smoking, and not a living soul to be found by the scouts. When from these, who had been despatched every way, it was learnt that whither the enemy had fled no certain traces could be discovered, and that they had nowhere rallied, it being impossible now the summer was passed to extend the war, he conducted his army into the borders of the Borestians. After he had there received hostages, he ordered the admiral of the fleet to sail round Britain For this expedition he was furnished with proper forces, and terror preceded him. He himself the while led on his foot and horse with a slow pace, that thus the minds of the newly conquered tribes might be awed by the actual slowness of his march: he then lodged his army in winter quarters The fleet, too, with favourable weather and great fame entered the harbour of Trutulirum; for thence it had sailed, and coasting along the nethermost shore of Britain, thither returned.

39. This course of events, not exaggerated by any boastful words in the letters of Agricola, Domitian heard, as was his wont, with joy in his countenance and anguish in his soul. His heart indeed smote him that his late mock triumph over the Germans was held in public derision; as to adorn it he had purchased a number of slaves, who were so decked in their dress and hair as to resemble captives in war. But here a victory mighty and certain, gained by the slaughter of so many thousands of the enemy, was celebrated with vast applause. Terrible above all things it was to him that the name of a private man should be exalted above that of a prince. In vain had he driven into obscurity the pursuits of the forum and the lustre of civil accomplishments if another possessed the glory of war: other successes might be overlooked; the valour of a great general was a quality worthy of an Emperor. Tortured with these anxious thoughts, and harassed by his secret reflections, a certain indication of a savage purpose, he at last judged it the best course, upon this occasion, to reserve his hatred till the fever of renown and the affection of the army had cooled. For Agricola held yet the administration of Britain.

40. To him therefore he caused to be decreed in the Senate the triumphal distinctions and the honour of a statue crowned with laurel, with whatever else is bestowed instead of a triumph, heightened with many expressions of honour, and he directed, moreover, a general expectation to be raised that to Agricola was destined the province of Syria, a province reserved for men of special distinction, then vacant by the death of Atilius Rufus, a man of consular rank. Many there were who believed that an imperial freedman, employed on confidential missions, was despatched to Agricola, and carried him the ordinance, by which Syria was offered to him, with orders to deliver it to him, were he still in Britain; that the freedman met Agricola actually crossing the channel, and without once speaking to him, returned directly to Domitian. It is uncertain whether this account be true, or only a fiction framed in accordance with the character of the prince. In the meanwhile Agricola had surrendered the province to his successor now settled in peace and security. And to prevent his entry into Rome rousing attention from any crowd and concourse of people to meet him, he shunned this observance of his friends, and came into the city by night and by night, as he was directed, went to the palace. He was there received by the Emperor with a hasty embrace, then without a word said mingled with the crowd of servile courtiers. Moreover, in order to soften with other virtues his character as a soldier, a character distasteful to civilians, he resigned himself entirely to repose and ease. In his dress he was modest, in his conversation easy; he was accompanied usually by one or two of his friends. Insomuch that many, such especially as are wont to judge of great men by their ostentation, when they had beheld and observed Agricola, sought to know the source of his mighty fame, while but few could account for it.

41. Frequently during that period in his absence was he accused before Domitian, and in his absence acquitted. The cause of his peril was no crime, nor complaint of any man he had injured, but the offence his virtues gave to the Emperor, the greatness of the man, and that worst class of enemies, those who praised him. Moreover a crisis of the commonwealth then ensued such as would not permit the name of Agricola to remain unmentioned: so many were the armies which were lost in Mœsia, in Dacia, in Germany, in Pannonia, by the recklessness or cowardice of the generals: so many were the men of war with so many cohorts overthrown and taken. The question was no longer one of maintaining the limits of the Empire and guarding the river bank, but of defending the winter quarters of the legions and our own territories. Thus, when losses followed losses in a continual train, when every year was marked with deaths and disasters, Agricola was demanded as general by the voice of the populace. All men were comparing his energy and firmness and his mind trained in war with the sloth and timidity of the others. With these discourses it is certain that even the ears of Domitian himself were attacked; whilst all the best of his freedmen out of pure affection and duty, the worst out of malevolence and envy, urged on the Emperor, already prone to take the worse course.

In this manner was Agricola, as well through his own virtues as through the faults of others, hurried headlong upon glory.

42. The year was now approaching when Agricola was to cast lots for the proconsulship of Asia or of Africa; and, as Civica had been lately murdered, Agricola did not want for warning, nor Domitian for precedent. It happened too that certain persons, familiar with the thoughts of the Emperor, on their own account asked Agricola whether he meant to go to the province. At first indeed somewhat vaguely they began to extol a life of tranquillity and repose; anon they proffered their good offices in making good his excuse; at last, throwing off all disguise, and proceeding at once to dissuade and to intimidate him, they brought him before Domitian. He, already equipped with pretences, and assuming a mien of haughtiness, not only received the petition of Agricola to be excused, but when he granted it, suffered himself to be thanked, and was not ashamed of the invidious character of the favour. To Agricola, however, he did not give the salary which was wont to be paid to a man of proconsular rank, and which he himself had granted to some, either affronted that it was not asked, or restrained by his own guilty mind, lest he should appear to have bought that which he had forbidden. It is peculiar to human nature to hate a man you have injured. Now the temper of Domitian, hasty to anger, the more irreconcilable the more it was concealed, was yet softened by the prudence and moderation of Agricola, because he did not challenge fame or fate by perversity or by any vain ostentation of liberty. Let those take notice who are wont to admire things forbidden, that even under evil princes great men may exist, and that compliance and self-restraint, provided these be accompanied with application and vigour, may rise to the same height of glory, whither most men have climbed by steep paths, rendering meanwhile no service to the State, and have become notorious by an effective death.

GREEK.—XIV.

[*Continued from p.* 6]

THE PRESENT AND IMPERFECT TENSES, ACTIVE VOICE.

THE present tense-stem is formed in many different ways from the simple verb-stem. We can only here roughly catalogue the various affixes as follows:—

(1) In *-μι* verbs, (*a*) sometimes the verb-stem is found without addition; sometimes the stem is formed (*b*) by reduplication, *e.g.*, **σι-στα-μι** gives **ἵ-στη-μι**; (*c*) by addition of **-νυ**, *e.g.*, **δείκ-νυ-μι**; (*d*) by addition of **-νη**, *e.g.*, **δάκ-νη-μι**.

(2) In **-ω** verbs, variously, by addition of **-δ**, **-σκο**, **y-ο**, **-το**, by reduplication, and by insertion of a nasal, *e.g.*:—**λεγ-ο-ο** = **λέγω**, **βο-σκο-ο** = **βόσκω**, **ἀγερ-yο-ο** = **ἀγείρω**, **τεμ-ν-ω** = **τέμνω**, etc.

The imperfect stem is formed from the present stem by prefixing the augment. The personal suffixes are those used in all the secondary tenses.

VOCABULARY.

Ἀγορεύω, I harangue, I say.
Ἄπειρος, -ον (adverb **ἀπείρως**), unskilful; **ἀπείρως ἔχειν**, to be ignorant of.
Ἀποτρέπω, I turn away, turn from.
Ἀποφεύγω, I flee.
Ἄροτρον, -ου, τό (Latin *aratrum*), a plough.
Γενναίως, generously, nobly, bravely.
Δεινός, -ή, -όν, fearful; **τὸ δεινόν**, peril.
Ἕτερος, -α, -ον (Latin *alter*), another.
Ἔχω, I have, possess.
Ἵνα, in order that [with subjunctive after a principal tense; with optative after an historical tense].
Κάλλος, -ους, τό, beauty.
Κεύθω, I conceal.
Μουσική, -ης, ἡ, art, music.
Ὅταν, when, whensoever [with subjunctive, indefinite].
Ὅτε, when [with indicative, definite].
Οὕτως (before consonants, **οὕτω**), thus.
Πλησιάζω, I draw near, approach.
Πρόνοια, -ας, ἡ, forethought; **πρόνοιαν ἔχειν**, to care for.
Προσπίπτω, I fall to, happen, befall.
Στασιάζω, I live in uproar, I disagree.
Τε — καί, both, as well as, and — and.

EXERCISE 72.

Translate into English:—

1. *Δύο ὅδω πρὸς τὴν πόλιν ἄγουσι.* 2. *Βόε τὸ ἄροτρον ἄγετον.* 3. *Χαίρωμεν, ὦ παῖδες.* 4. *Ὡς ἡδὺ* (sc. *ἐστι*) *κάλλος, ὅταν ἔχῃ νοῦν σώφρονα.* 5. *Οἱ πολῖται τοὺς νόμους φυλαττόντων.* 6. *Ἑταῖρος ἑταίρου φροντιζέτω.* 7. *Πατήρ τε καὶ μήτηρ πρόνοιαν ἐχέτων τῆς τῶν τέκνων παιδείας.* 8. *Ὁ γραμμάτων ἄπειρος οὐ βλέπει βλέπων.* 9. *Τὰς προσπιπτούσας τύχας γενναίως φέρε.* 10. *Ὁ παῖς τῷ πατρὶ ῥόδυν φέρει, ἵνα χαίρῃ.* 11. *Ὁ παῖς τῷ πατρὶ ῥόδον ἔφερεν, ἵνα χαίροι.* 12. *Σωκράτης ὥσπερ ἐγίγνωσκεν οὕτως ἔλεγεν.* 13. *Ὅτε οἱ Ἕλληνες ἐπλησίαζον, οἱ βάρβαροι ἀπέφευγον.* 14. *Θεμιστόκλης καὶ Ἀριστείδης ποτὲ ἐστασιαζέτην.* 15. *Οἱ Λακεδαιμόνιοι μουσικῆς ἀπείρως ἔχουσιν.* 16. *Ἀποτρέποιτε, ὦ θεοί, τὸ δεινὸν ἀφ' ἡμῶν.* 17. *Μὴ ἕτερον κεύθῃς ἐν καρδίᾳ νοῦν, ἄλλα ἀγορεύων.*

N.B.—The subjunctive of the first person plural expresses an *exhortation* (= the imperative), *e.g.*, **χαίρωμεν**, *let us rejoice.*

The imperfect often denotes a repeated act, and must sometimes be rendered with the aid of the verb *to accustom;* thus: **ἔλεγε**, *was accustomed* (*used*) *to speak.* The optative, as expressive of a *wish*, may be used as a softened imperative, as:—**Ἀποτρέποιτε**, etc., *O that you would turn away*; that is, *turn away.*

EXERCISE 73.

Translate into Greek:—

1. This road leads to the city. 2. Two horses drive the plough. 3. Women are beautiful when they have good sense. 4. The citizen keeps the laws. 5. The citizens used to keep the laws. 6. Keep the laws, O citizens. 7. My father takes care of my education. 8. My mother and my sisters took care of my education. 9. The citizens nobly

bear the chances that befall. 10. The mother brings a rose to the father, that he may rejoice. 11. The sister brought a rose to her brother, that he might rejoice. 12. The daughter, the mother, and the father disagreed. 13. Do not (*O that ye would not*) disagree, O parents! 14. The boys were rejoicing. 15. My sister was rejoicing. 16. The young man is ignorant of music. 17. These girls are ignorant of music. 18. Those who are unskilled in letters, though they have eyes, see not. 19. Those women are unskilled in letters. 20. Two men are fleeing. 21. He conceals his thought in his heart. 22. When the barbarians approached, he fled. 23. May the gods (opt.) turn the danger from us.

THE FUTURE TENSE AND FIRST AORIST, ACTIVE VOICE.

The stem of the future is formed from the simple stem by the addition of σ: *e.g.*, λυ-, λυσ-. Λυσ- is the stem of the future; subjoin the person-endings, and you have the tense in full.

The first aorist stem is formed from the stem of the future by prefixing to that stem the augment; and affixing the person-endings, as given in the paradigm, we obtain the tense in full. For example, the future and first aorist of ἀγορεύω are thus formed :—

ἀγορευ-, Future, ἀγορευσ-, ἀγορεύσω, -εις, -ει, etc.
ἀγορευσ-, Aorist First, ἐ-αγορευσ- =
ἠγόρευσα, -ας, -ε, etc.

VOCABULARY.

Ἀβλάβεια, innocence, innocuousness (ἀ, not; βλαβή, injury).
Ἀγαμέμνων, -ονος, ὁ, Agamemnon.
Ἄμφω, both.
Ἀπολύω, I free from (ἀπό *and* λύω).
Δάκρυον, -ου, τὸ, a tear.
Διαλύω, I put an end to (διὰ *and* λύω).
Δικάζω, I judge (δίκη, justice, judgment).
Δικαστής, -ου, ὁ, a judge.
Ἔκγονος, -ου, ὁ *and* ἡ, a descendant, offspring.
Ἕκτωρ, -ορος, ὁ, Hector.
Ἐπαγγέλλω, I announce, report (ἄγγελος, a messenger; hence our *angel*).
Ἐπιβουλεύω, I plot against.
Ἔσχατος, -η, -ον, the last, extreme
Ἱκετεύω, I implore.
Καί, even, also (in Latin *etiam*).
Καταλύω, I destroy (κατὰ *and* λύω).
Κινδυνεύω, I am in danger, I incur danger.
Μηνίω, I owe a grudge, I am angry with.
Ὅτι, that.
Πλατεῖαι, -ων, ἡ, Platæa.
Στρατία, -ας, ἡ, an army.
Φυτεύω, I plant.

EXERCISE 74.

Translate into English :—

1. Οἱ στρατιῶται τὴν πόλιν ἀπὸ τῶν πολεμίων ἀπολύσουσιν. 2. Ὁ χρηστὸς ἄνθρωπος καὶ τοῖς ἐκγόνοις φυτεύσει. 3. Ὁ ἄγγελος ἐπήγγελλε τοῖς πολίταις, ὅτι οἱ πολέμιοι τῷ στρατεύματι ἐπιβουλεύσοιεν. 4. Ἀχιλλεὺς Ἀγαμέμνονι ἐμήνῖσεν. 5. Οἱ Ἕλληνες ἀνδρείᾳ πολλὰ ἴσχῦσαν. 6. Σωκράτης οὐχ ἱκέτευσε τοὺς δικαστὰς μετὰ πολλῶν δακρύων, ἀλλὰ πιστεύσας τῇ ἑαυτοῦ ἀβλαβείᾳ ἐκινδύνευσε τὸν ἔσχατον κίνδῦνον. 7. Μὴ δίκαζε πρὶν ἂν ἄμφοιν μῦθον ἀκούσῃς. 8. Οἱ Λακεδαιμόνιοι Πλαταίας κατέλῦσαν. 9. Τίς ἂν πιστεύσαι (πιστεύσειε) ψευστῇ; 10. Ἀκούσαις (ἀκούσειας) μοῦ, ὦ φίλε. 11. Ὁ ἄγγελος ἐπήγγελλεν, ὅτι οἱ πολέμιοι τῇ στρατίᾳ ἐπιβουλεύσαιεν (ἐπιβουλεύσειαν). 12. Ἄκουσόν μου, ὦ φίλε. 13. Ἑταῖρος ἑταίρῳ πιστευσάτω. 14. Τὴν πόλιν λέγουσι μέγαν κίνδῦνον κινδυνεῦσαι.

Note.—Πρὶν ἄν, *before* (with subjunctive or optative when referring to the future, after negative sentences); ἄν refers to a condition expressed or understood.

In the exercise ἐπήγγελλε is the third person singular of the imperfect indicative; the η between επ (επι) and the verb is the temporal augment, formed by lengthening the α, the first letter in the verb ἀγγέλλω. In ἰσχύω and ἱκετεύω the augment is formed by simply lengthening the ι.

Ἐπιβουλεύσαιεν is optative because the sentence expresses the reported statement of another person, *i.e.*, is *Oratio Obliqua*. In English we express this by changing the *tense* to the past; Greek always keeps the same tense that would have been used in *Recta*, but changes the MOOD to the OPTATIVE.

EXERCISE 75.

Translate into Greek :—

1. The general will free the city from the enemy (plural). 2. Good men plant for their offspring also. 3. The messengers report many things. 4. The enemy plot against the king. 5. The enemy plot against me. 6. I shall announce many things to the citizens. 7. Achilles will be angry with Agamemnon. 8. Thou art angry with thy brother. 9. I was angry with the enemy. 10. I will entreat my judges. 11. The good citizens will not entreat their judges. 12. The enemy are destroying Platæa. 13. The soldiers will destroy Platæa. 14. The soldiers destroyed the city. 15. Hear me, O my offspring. 16. One friend will believe another. 17. One friend did believe another. 18. Thou wilt believe. 19. They two believed. 20. We shall believe. 21. The soldier prevails much by his valour. 22. I prevailed much by my valour.

THE PERFECT, PLUPERFECT, AND OTHER TENSES.

The perfect stem is formed from the simple stem by adding κ and prefixing the reduplicative augment, as λυ-, λυκ-, λε-λυκ-; the tense itself is formed by adding to the stem the person-endings. We are now speaking exclusively of the active voice. Observe that as σ is in general the sign of the future and the first aorist, so is κ generally the sign of the perfect and the pluperfect. Qualifications of these statements will appear as we proceed.

To form the stem of the pluperfect, prefix ε to the stem of the perfect. Thus, to λελυκ- we prefix ε, and produce ελελυκ-, which, when the person-endings are suffixed, constitutes the pluperfect tense.

VOCABULARY.

Γυναικεῖος, -α, -ον, womanly, belonging to a woman.
Δαρεῖος, -ου, ὁ, Darius.
Διοδῶρος, -ου, ὁ, Diodórus.
Ἐνδύω, I enter, I put on.
Ἐπιδιώκω, I pursue.
Καταδύω, I go down, sink.
Κυριεύω, I become master of, gain.
Μάντις, -εως, ὁ, a soothsayer, a diviner.
Μέλλω, I purpose, I am on the point of; *τὸ μέλλον*, the future.
Μήδεια, -ας, ἡ, Medéa.
Πέρσης, -ου, ὁ, a Persian.
Πολέμιος, -ου, ὁ, an enemy.
Προφητεύω (our word *prophesy*), I foretell.
Σαρδανάπᾱλος, -ου, ὁ, Sardanapálus.
Φερεκύδης, -ους, ὁ, Pherecydes.
Φονεύω, I kill, slay, murder.
Φύω, I beget, produce (in the perfect, *I am produced, I have become*).

EXERCISE 76.

Translate into English:—

1. Οἱ στρατιῶται τῶν πολεμίων δισχιλίους διακοσίους ἑξήκοντα πέντε πεφονεύκασιν. 2. Φερεκύδης ἔλεγε μηδενὶ θεῷ τεθυκέναι. 3. Νέος πεφυκὼς πολλὰ χρηστὰ μάνθανε. 4. Ὁ μάντις τὰ μέλλοντα καλῶς πεπροφήτευκεν. 5. Τὰ τέκνα εὖ πεπαίδευκας. 6. Μήδεια τὰ τέκνα πεφονευκυῖα ἔχαιρεν. 7. Οἱ Λακεδαιμόνιοι Πλαταίας κατελελύκεσαν. 8. Σαρδανάπᾱλος στολὴν γυναικεῖαν ἐνεδεδύκει. 9. Ὅτε ὁ ἥλιος κατεδεδύκει, οἱ πολέμιοι ἐπλησίαζον. 10. Ἀλέξανδρος ἐπιδιώκων Δαρεῖον, τὸν Περσῶν βασιλέα, πολλῶν χρημάτων ἐκεκυριεύκει.

EXERCISE 77.

Translate into Greek: -

1. I have slain. 2. They have slain. 3. He had slain. 4. They will slay. 5. He slew. 6. We will slay. 7. We have slain. 8. We had slain. 9. They will sacrifice. 10. They have sacrificed. 11. They had sacrificed. 12. They sacrificed. 13. The soothsayer sacrificed to the god. 14. The soothsayer has sacrificed to the god one hundred oxen. 15. I educate my children. 16. I was educating my children. 17. He had educated his own children. 18. Alexander destroyed Babylon. 19. Alexander had destroyed Babylon. 20. The boy will put on a woman's garment.

Note.—In forming the tenses of verbs compounded with prepositions, the student is advised to drop the preposition while so doing, restoring it afterwards. For instance, in ἐνδύω drop the ἐν, and form the stems according to rule; thus, δυ-, δυσ-, ἐδυσ-, δεδυκ-, ἐδεδυκ-; ἐν-ε-δε-δυ-κ-, that is, ἐνεδεδυκ-. So with καταλύω: λυ-, λυσ-, ελυσ-, λελυκ-, ελελυκ-; κατελελυκ-—where observe that κατα loses its final α before the vowel ε.

PRESENT AND IMPERFECT, MIDDLE OR PASSIVE.

The present middle or passive is formed from the stem of the present active by adding -ομαι—as λυ-, λύ-ομαι. Of -ομαι the ο may be considered as a connecting vowel, -μαι being the person-ending. This connecting vowel is seen in other persons of the same tense; thus, λύ-ο-μαι, λύ-ε-ται, λύ-ε-σθον, λυ-ό-μεθα, λύ-ε-σθε, λύ-ο-νται, where ε and ο are the connecting vowels—vowels, that is, that unite the stem with the person-endings.

The imperfect middle or passive is formed by prefixing the augment and changing -μαι into -μην; thus, λύομαι, ἐ-λυό-μην. It may also be formed from the imperfect active by changing the active termination -ον into the middle termination -όμην.

VOCABULARY.

Ἀδελφός, -οῦ, ὁ, a brother.
Ἀποδέχομαι, I receive, am favourable to, welcome.
Αὐλός, -οῦ, ὁ, a flute.
Ἐγχώριος, -ον, domestic, belonging to the country (*χώρα*).
Εἴθε (with the optative), O that!
Ἐργάζομαι (from *ἔργον*, work), I work.
Ἔρχομαι, I come, go.
Λανθάνω (Latin *lateo*), I lie hid, am concealed.
Πένομαι (*πενής*, poor; Latin *penuria*; English *penury*), I am poor.
Πράττω, I do; *πράττω καλῶς*, I do (fare) well—that is, *I am in a good condition; e.g.*, *πῶς πράττεις* = how do you do?).
Στρατεύω (from *στρατία*, an army), I make an expedition.
ψεύδομαι (from *ψεῦδος*, a falsehood), I lie.

EXERCISE 78.

Translate into English:—

1. Δύο ἄνδρε μάχεσθον. 2. Γενναίως μαχώμεθα περὶ τῆς πατρίδος. 3. Ἀναγκαῖόν ἐστι τὸν υἱὸν πείθεσθαι τῷ πατρί. 4. Πολλοὶ ἀγαθοὶ πένονται. 5. Νόμοις τοῖς ἐγχωρίοις ἕπεσθαι καλόν ἐστιν. 6. Μὴ ἀποδεχοῦ τῶν φίλων τοὺς πρὸς τὰ φαῦλα χαριζομένους. 7. Ἕκαστος ἥσυχος μεσὴν τὴν ὁδὸν ἐρχέσθω. 8. Οἱ πολῖται τοῖς νόμοις πειθέσθων. 9. Τὼ ἀδελφώ μοι ἑπεσθον. 10. Εἰ βούλει καλῶς πράττειν, ἐργάζου. 11. Ἐὰν βούλῃ καλῶς πράττειν, ἐργάζου. 12. Ψευδόμενος οὐδεὶς λανθάνει πολὺν χρόνον. 13. Οἱ Λακεδαιμόνιοι μετ' αὐλῶν ἐστρατεύοντο. 14. Εἴθε πάντες ἄνευ ὀργῆς βουλεύοιντο. 15. Δύο καλὼ ἵππω εἰς τὴν πόλιν ἠλαυνέσθην. 16. Ἐὰν πένῃ, ὀλίγοι φίλοι εἰσί σοι.

Note.—Μὴ ἀποδεχοῦ, etc. If this sentence be arranged a little differently, the student will be better able to see its meaning:—Μὴ ἀποδεχοῦ τοὺς τῶν φίλων (or τῶν φίλων τοὺς) χαριζομένους σοι πρὸς

τὰ φαῦλα; in English, *Do not welcome those of your friends who gratify you in bad things.* **Πρὸς** (Latin *ad*), *in regard to, in.*

The conjunction **εἰ** requires an indicative or optative mood; the conjunction **ἐὰν** takes a subjunctive.

Μετ' αὐλῶν, *with flutes*—that is, *to the sound of flutes.*

Ἐργάζομαι, and several other verbs, such as **ἕλκω, ἕπομαι**, beginning with **ε**, form their temporal augment by changing **ε** into **ει**.

EXERCISE 79.

Translate into Greek:—

1. That man is poor, and has few friends. 2. They two were consulting. 3. Thou wishest to fare well, work. 4. If (**ἐάν**) you wish to fare well, work. 5. He was working well. 6. They were fighting bravely. 7. You were fighting. 8. O soldiers, fight bravely for your country. 9. It is honourable to fight for one's country. 10. I follow thee. 11. He follows me. 12. They follow me. 13. We follow the general. 14. We were following the army. 15. Obey the laws, O boys.

THE PERFECT AND PLUPERFECT PASSIVE.

The perfect passive may be formed directly from the perfect active by changing **-κα** into **-μαι**; as, perfect active **λέλυ-κα**, perfect passive **λέλυ-μαι**.

The pluperfect passive may be formed from the perfect by changing **-μαι** into **-μην**, and prefixing the augment **ε**; as, perfect **λέλυ-μαι**, pluperfect **ἐ-λελύ-μην**.

VOCABULARY.

Ἄκρα, -ας, ἡ, a summit, a fort *or* citadel.

Αὐτονομία, -ας, ἡ (**αὐτός**, *self*, and **νόμος**, *law*), self-government, freedom, independence.

Ἐμφυτεύω, I plant in (**ἐν**, and **φυτεύω**, I plant).

Ἱδρύω, ἱδρύσω, ἵδρυμαι, I sit down, place, build.

Κατακλείω, -κλείσω, -κέκλεισμαι (from **κλείς**, a key), I shut up.

Λέγομαι (Latin *dicor*), I am said.

Λῃστής, -οῦ, ὁ, a thief, a robber, a pirate.

EXERCISE 80.

Translate into English:—

1. **Οἱ λῃσταὶ πεφόνευνται.** 2. **Δύο ἀδελφὼ ὑπὸ τοῦ αὐτοῦ διδασκάλου πεπαίδευσθον.** 3. **Ἡ βασιλεία ὑπὸ τοῦ δήμου λέλυται.** 4. **Τοῖς θεοῖς ὑπὸ τῶν Ἀθηναίων πολλοὶ νεῲ ἵδρυνται.** 5. **Ἡ θύρα κεκλείσθω.** 6. **Πρὸ τοῦ ἔργου εὖ βεβούλευσο.** 7. **Πᾶσιν ἀνθρώποις ἐμπεφυτευμένη ἐστὶν ἐπιθυμία τῆς αὐτονομίας.** 8. **Οἱ λῃσταὶ πεφονεύσθων.** 9. **Οἱ πολέμιοι εἰς τὴν ἄκραν κατακεκλεῖσθαι λέγονται.** 10. **Ξενοφῶντος υἱώ, Γρύλλος καὶ Διόδωρος, ἐπεπαιδεύσθην ἐν Σπάρτῃ.**

Note.—**Κεκλείσθω**, *let the door have been shut.* This, which is something like the literal rendering of the imperative perfect passive, scarcely makes sense in English. The force of the perfect lies in representing the action as already done, and so in denoting despatch, as in our vulgarism *have done*—that is, *cease immediately.*

Εἰς τὴν ἄκραν, *into the citadel;* **εἰς** with the accusative, instead of **ἐν** with the dative, being used, because motion is implied. In English, however, we say in such a case, "*in* the citadel."

EXERCISE 81.

1. He has been murdered. 2. The boys have been murdered. 3. The soldiers had been slaughtered. 4. He has been shut up. 5. Ye have been shut up. 6. Ye had been shut up. 7. They have been shut up. 8. The two men had been shut up. 9. The oxen are said to have been shut up. 10. I have been well educated. 11. Thou hadst been well educated. 12. They have been well educated. 13. I had been ill educated. 14. The trees have been well planted. 15. The trees had been ill planted.

KEY TO EXERCISES.

Ex. 68.—1. I might loose myself. 2. I would loose myself. 3. I am loosing myself. 4. I may loose myself. 5. I was loosing myself. 6. I loosed myself. 7. I shall loose myself. 8. I was left behind. 9. They are loosing themselves. 10. They were loosing themselves. 11. They loosed themselves. 12. You might have loosed (*or* might loose) yourselves. 13. I might have been (*or* might be) left behind. 14. To be left behind. 15. Having been left behind. 16. To have loosed oneself. 17. To loose oneself. 18. Loosing oneself. 19. Loose yourselves. 20. I may have remained behind. 21. You loosed yourself. 22. He may have loosed himself. 23. Let them both loose themselves. 24. You two might loose yourselves. 25. Of one loosing himself. 26. You were loosing yourselves. 27. Having loosed themselves. 28. They might loose themselves. 29. We might have loosed ourselves.

Ex. 69.—1. **Λυοίμην.** 2. **Λύοιτο.** 3. **Λύοιντο.** 4. **Λύεσθαι.** 5. **Λυόμενος.** 6. **Λύσασθε.** 7. **Λύσοιτο.** 8. **Λυέσθω.** 9. **Λυσώμεθα.** 10. **Λύσονται.** 11. **Λύηται.** 12. **Λύσαισθον.** 13. **Λύσῃ.** 14. **Ἐλίπεσθε.** 15. **Λίπηται.** 16. **Λίπεσθε.** 17. **Λύσασθαι.**

Ex. 70.—1. He was rubbed. 2. Thou mayest be rubbed. 3. Thou wouldest be rubbed. 4. He would be rubbed. 5. They two might have been loosed. 6. They might have been loosed. 7. Let him be loosed. 8. To have been (*or* to be) loosed. 9. Being about to be loosed. 10. To have been (*or* to be) rubbed. 11. Being about to be rubbed. 12. Thou wast loosed. 13. Ye were loosed. 14. Thou shalt be loosed. 15. We may have been loosed. 16. We might have been loosed. 17. They may have been loosed. 18. Having been loosed. 19. To be about to be loosed. 20. Having been rubbed. 21. Let him be rubbed. 22. I have been loosed. 23. I had been loosed. 24. I shall have been loosed. 25. They have been loosed. 26. They had been loosed. 27. Thou mightest have been loosed.

Ex. 71.—1. **Ἐλύθη.** 2. **Λυθῇ.** 3. **Λυθείη.** 4. **Τριβήσεται.** 5. **Λυθήσονται.** 6. **Ἐτρίβη.** 7. **Λέλυμαι.** 8. **Λελυμένος ἦς.** 9. **Λελύσονται.**

ENGLISH LITERATURE.—VII.

[Continued from p. 10.]

THE ELIZABETHAN PERIOD—SPENSER.

EDMUND Spenser was born in London, about the year 1552. He was educated at Merchant Taylors' School, and in 1569 we find that he entered Pembroke Hall, Cambridge. That he there pursued his studies with diligence, and laid the foundation of a very unusual amount of learning and an immense knowledge of literature, no one who reads his poems can doubt; for few poets have drawn their materials from more varied sources, or used those materials more thoroughly with the ease and naturalness which spring from long and intimate familiarity, than Spenser. During his college career, Spenser formed a close friendship with a man who enjoyed a very high reputation for learning and literary ability, Gabriel Harvey—a friendship which ultimately exercised a great influence over Spenser's career. Harvey was the leader of a fashion—which his influence rendered not unusual for a time—of adapting the ancient classical metres (founded on quantity, not like English metres on accent) to English poetry; and Spenser, as his correspondence with Harvey shows, was infected by his friend's fancy for a time, though this eccentricity did not in Spenser's case last long. Harvey, however, did for Spenser the real service of introducing him to Sir Philip Sidney, who proved, as long as his short life lasted, Spenser's most faithful friend and generous protector. To the friend and favourite of Sidney the society of all the most eminent men of the day was naturally open; and Spenser soon found friends or patrons in Leicester, Essex, Raleigh, and many more among the statesmen or courtiers who adorned the brilliant Court of Elizabeth. Nor was it long before he became known to the Queen herself. Spenser had probably written much poetry which has since been lost, and perhaps some of the minor pieces which we still possess, before or very soon after he left the university; but the first poem by which he attracted the notice of the Court, and established his reputation as the great poet of the day, was "The Shepherd's Calendar." This work is in form a series of twelve idyls, or pastoral dialogues, one for each month in the year. But the poems are pastoral only in form; for sometimes, under the guise of shepherds, we have Colin Clout (the poet himself) and Hobbinol (his friend Harvey), or others of like character, moralising upon old age; sometimes discussing the pleasures and pains of love; sometimes singing the praises of Queen Elizabeth; sometimes discussing the progress of poetry and the condition of poets; and sometimes the comparative merits of the Catholic and Protestant systems, and the vices of the worldly clergy.

By this work, and through the influence of Sidney and those to whose favour Sidney had recommended him, Spenser's connection with the Court was established; and from time to time he seems to have received unimportant employment in the public service. But his favour with Leicester almost necessarily implied disfavour with Leicester's opponents; and thus at first no great benefit from the royal partiality fell to his share. Probably at this time, and almost certainly at a later period, the Lord Treasurer Burleigh was his foe; and the painfulness of what he then and afterwards endured is strikingly expressed by him in the well-known lines in "Mother Hubbard's Tale":—

> "Most miserable man, whom wicked fate
> Hath brought to court to sue for had ywist,
> That few have found and many one hath mist!
> Full little knowest thou that hast not tried,
> What hell it is in suing long to bide;
> To lose good days, that might be better spent;
> To waste long nights in pensive discontent;
> To speed to-day, to be put back to-morrow;
> To feed on hope, to pine with fear and sorrow;
> To have thy prince's grace, yet want her peers';
> To have thy asking, yet wait many years;
> To fret thy soul with crosses and with cares;
> To eat thy heart through comfortless despairs;
> To fawn, to crouch, to wait, to ride, to run,
> To spend, to give, to want, to be undone.
> Unhappy wight, born to disastrous end,
> That doth his life in so long tendance spend."

In 1580, Lord Grey de Wilton was appointed lord-deputy of Ireland, and Spenser went to Ireland with him as secretary. He soon acquired a more lasting tie to that country. Through the influence, no doubt, of his powerful friends, he received a grant of land in the county of Cork, a portion of the forfeited estates of the Earls of Desmond, together with the castle of Kilcolman. This became thenceforth his usual and permanent place of abode, and was the scene in which he composed the greater and more important part of his works; though his visits to England and to the Court, for the purpose of seeing his works through the press and presenting them to the Queen and his other patrons, were frequent. But in 1598 a calamity befell him which embittered the short remainder of his life, and perhaps hastened his end. Rebellion again broke out in Ireland in 1598; the confiscated lands were overrun; Spenser and his family fled in haste from Kilcolman; the Irish seized and burnt the castle; and one of Spenser's children, who had (we know not how) been left behind, perished in the flames. Spenser returned to London, and the next year died, it has been said—with what truth we cannot tell—in great distress and poverty.

The first important contribution of Spenser to literature, during his residence in Ireland, was the publication of the first three books of the "Faëry Queen," in 1590. In an age of such intellectual activity, in which the popular avidity for poetry was so keen, and the patronage of the Court towards literary men so liberal, it is easy to conceive the enthusiasm which the work excited. It was the first really great poem which had been produced in England since the "Canterbury Tales"; and the time was especially favourable for its reception, so that its merits were appreciated at once. The success of the work led to an eager demand for anything which Spenser could supply. The following year a collection of shorter pieces was published under the name of "Complaints." It included the "Ruins of Time," a poem mainly commemorative of the death of Sir Philip Sidney, and dedicated to his famous sister, the Countess of Pembroke; "The Tears of the Muses"; "Virgil's Gnat"; "Mother Hubbard's Tale," a social and political satire; "Muiopotmos, or the Tale of the Butterfly"; "The Ruins of Rome" and "The Visions of Bellay," translated from the French poet Bellay; "Visions of the World's Vanity," and "Visions of Petrarch." In rapid succession followed "Daphnaïda," an elegy on the death of a lady of the Howard family; "Colin Clout's Come Home Again," a poem in which he returned to the pastoral form used by him in earlier life, which is dedicated to Sir Walter Raleigh, and contains many allusions to contemporary poets; "Astrophel," an elegy, likewise pastoral in form, on the death of Sir Philip Sidney; "Amoretti, or Sonnets," probably written during, and with reference to, his courtship; and "Epithalamium," a bridal hymn upon his own marriage. In 1596 were published three more books of the "Faëry Queen," making, with the previous three, the whole of that poem which was ever published in a complete form. In the short interval between this period and his death, he published "Prothalamium," a marriage song on the marriage of the daughters of the Earl of Worcester; four hymns in honour of Love, Beauty, Heavenly Love, and Heavenly Beauty; and a few shorter and less important poems. After his death were published some fragments of later and unfinished books of the "Faëry Queen." He also left behind him a remarkable prose work, a "View of the State of Ireland," which was not printed till long after his death. -

Our space does not allow us to enter upon any detailed examination of Spenser's minor poems; and this is the less important, because the "Faëry Queen" is so much the most characteristic work of Spenser's genius, as well as being the poem of far the greatest intrinsic merit, that an acquaintance with the "Faëry Queen" will give a sufficient comprehension of Spenser's qualities as a poet.

The "Faëry Queen," even in its unfinished state, is a poem of great length; and the six books completed are only half of the poem as projected. The unfinished state of the poem, moreover, leaves it in a disjointed condition, the several books being connected with one another only by the slenderest thread. The general plan of the whole was intended to have been developed in a later portion. But, fortunately, we have a letter of the author addressed to Sir Walter Raleigh, and prefixed to the first three books of the "Faëry Queen," in which he set forth his plan with great clearness, and from which we give a few extracts rather than tell the story in any other than Spenser's own words. He says that "the general end of all the book is to fashion a gentleman or noble person in virtuous and gentle discipline; which for that I conceived should be most plausible and pleasing, being coloured with an historical fiction, the which the most part of men delight to read, rather for variety of matter than for profit of the ensample, I chose the history of King Arthur, as most fit for the excellency of his person, being made famous for many men's former works, and also furthest from the danger of envy and suspicion of present time. . . . So have I laboured to do in the person of Arthur; whom I conceive, after his long education by Timon, to whom he was by Merlin delivered to be brought up so soon as he was born of the Lady Igrayne, to have seen in a dream or vision the Faëry Queen, with whose excellent beauty ravished, he, awaking, resolved to seek her out; and so, being by Merlin armed, and by Timon thoroughly instructed, he went to seek her forth in Faëry land. In that Faëry Queen I mean Glory in my general intention, but in my particular, I conceive the most excellent and glorious person of our Sovereign the Queen, and her kingdom in Faëry land. And yet in some places I do otherwise shadow her; for, considering she beareth two persons, the one of a most royal queen or empress, the other of a most virtuous and beautiful lady, this latter part in some places I do express in Belphœbe. So in the person of King Arthur I do set forth Magnificence in particular: which virtue, for that (according to Aristotle and the rest) it is the perfection of all the rest, and containeth in it them all, therefore, in the whole course of it, I mention the deeds of Arthur appliable to that virtue which I write of in that book. But of the twelve other virtues I make twelve other knights the patrons, for the more variety of the history." He then explains that the first book contains the adventures of the Red Cross Knight, who stands for *Holiness;* the second, of Guyon, or *Temperance;* the third, of Britomartis, a lady knight, representing *Chastity.* The three books subsequently published contain the legends of Cambell and Triamond, the patrons of *Friendship;* Artegall, or *Justice;* and Calidore, or *Courtesy.* Spenser further informs us that "the beginning of my history, if it were to be told by an historiographer, should be the twelfth book, which is the last; where I devise that the Faëry Queen kept her annual feast twelve days, upon which twelve several days the occasions of the twelve several adventures happened, which being undertaken by twelve several knights, are in these twelve books severally handled and discoursed."

To a poet of Spenser's peculiar genius this plan afforded special advantages. Spenser's genius was in no degree dramatic. He has nowhere shown any power of conceiving or portraying character, or of giving human interest to his story by arousing our sympathies with the joys and griefs, the struggles and triumphs of his heroes. There is nothing in his mere narrative to excite interest or curiosity. The charm of his poetry is of a very different kind—indeed it might almost be said, of an opposite kind. The very remoteness of all he describes from real life is one of its sources of pleasure. His unequalled fertility of imagination in producing images of beauty and purity, his power of invention as well as of description, and not less the singularly sweet though somewhat monotonous melody of his versification, find their most suitable field in visions of fairy land and vague allegories, the wanderings and adventures of elfin knights and fairy ladies.

But, in addition to the sources of pleasure in the "Faëry Queen," which are intrinsic and permanent, and no less appreciable by us than by the Elizabethan reader, Spenser's judgment in the selection of his subject was shown by the opportunity which it gave him of introducing a thousand allusions to things and people of his own day—allusions which probably had, and were intended to have, the effect of removing for contemporary readers the tone of monotony and sameness which it unquestionably has for modern readers. Thus the Fairy Queen herself is, as we have seen, Elizabeth. The evil witch Duessa was probably not only the representative of Falsehood, but stood for her rival, Mary Queen of Scots, as well. Artegall, the patron of Justice, is Lord Grey de Wilton, the lord-deputy of Ireland, under whom Spenser served. References to the Spanish wars and the various incidents in the ecclesiastical history of the reign are numerous; and there are, doubtless, many covert meanings of the same kind, which we now miss, but which were plain enough to Spenser's contemporaries.

The earlier books of the "Faëry Queen" are, by universal consent, of greater merit than the later; and probably we cannot in any way better assist the student in acquiring a knowledge of the general character of the poem than by a somewhat close examination of the first book. And the extracts which we give will enable everyone to appreciate the metre in which it is written—a metre which, it must be remembered, was of Spenser's own formation, though to some extent founded upon an Italian model.

The first book contains the adventures of the Red Cross Knight, or Holiness. Like each of the other books, it is divided into twelve cantos; and there is little doubt that under the guise of the Red Cross Knight the poet intended to describe the various fortunes of the Church of England.

The source and beginning of the adventures of this book are described by Spenser in the letter from which we have already quoted. The twelve-day festival of the Fairy Queen was being held. "In the beginning of the feast there presented himself a tall, clownish young man, who, falling before the Queen of Faëries, desired a boon (as the manner then was), which during that feast she might not refuse; which was that he might have the achievement of any adventure which during that feast should happen. That being granted, he rested him on the floor, unfit through his rusticity for a better place. Soon after entered a fair lady in mourning weeds, riding on a white ass, with a dwarf behind her leading a warlike steed, that bore the arms of a knight, and his spear in the dwarf's hand. She, falling before the Queen of Faëries, complained that her father and mother, an ancient king and queen, had been by a huge dragon many years shut up in a brazen castle, who thence suffered them not to issue; and therefore besought the Faëry Queen to assign her some one of her knights to take on him that exploit. Presently that clownish person, upstarting, desired that adventure; whereat the queen much wondering, and the lady much gainsaying, yet he earnestly importuned his desire. In the end, the lady told him that unless that armour which she brought would serve him (that is, the armour of a Christian man specified by St. Paul, Ephes. v.), that he could not succeed in that enterprise; which being forthwith put upon him, with due furnitures thereunto, he seemed the goodliest man in all the company, and was well liked of the lady. And eftsoons taking on him knighthood, and mounting on that strange courser, he went forth with her on that adventure;

where beginneth the first book." The once clownish young man has become the Red Cross Knight, or St George; the lady is Una, who represents true religion. They are thus introduced to us —

EDMUND SPENSER.

> "A gentle knight was pricking on the plain,
> Y-clad in mighty arms and silver shield,
> Wherein old dints of deep wounds did remain,
> The cruel marks of many a bloody field
> Yet arms till that time never did he wield,
> His angry steed did chide his foaming bit,
> As much disdaining to the curb to yield,
> Full jolly knight he seemed, and fair did sit,
> As one for knightly jousts and fierce encounters fit
>
> "And on his breast a bloody cross he bore,
> The dear remembrance of his dying lord,
> For whose sweet sake that glorious badge he wore,
> And dead, as living ever, him adored,
> Upon his shield the like was also scored,
> For sovereign hope, which in his help he had
> Right, faithful true he was in deed and word,
> But of his cheer did seem too solemn sad,
> Yet did he nothing fear, but ever was ydrad
>
> "A lovely lady rode him fair beside,
> Upon a lowly ass more white than snow
> Yet she much whiter, but the same did hide
> Under a vail, that wimpled was full low,
> And over all a black stole she did throw,
> As one that inly mourned, she was so sad,
> And heavy sat upon her palfrey slow,
> Seemed in heart some heavy care she had,
> And by her in a line a milk white lamb she lad.
>
> "So pure and innocent, as that same lamb,
> She was in life, and every virtuous lore,
> And by descent from royal lineage came
> Of ancient kings and queens, that had of yore
> Their sceptres stretched from east to western shore,
> And all the world in their subjection held,
> Till that infernal fiend with foul uproar
> Forwasted all their land, and them expelled;
> Whom to avenge, she had this knight from far compelled."

We find them first taking refuge from a storm in a wood, which proves to be the Wandering Wood, in which is the den of Error, a horrible monster, half woman, half snake, whom, after a terrible combat, the knight at last slays. They next meet an old man, seemingly a hermit, who leads them to his cell for the night

> "A little lowly hermitage it was,
> Down in a dale, hard by a forest side,
> Far from resort of people, who did pass
> In travel to and fro

The hermit turns out to be the great enchanter Archimago, who throughout the "Faery Queen" is the constant representative of all that is false and evil. Here he stands for heresy and deceit. By his deceptions the knight is led to believe that the lady is false and unchaste, and leaving her behind, starts by himself from the hermitage. He has not gone far, when he meets and slays "a faithless Sarazin"—Sansfoy, one of the three sons of Archimago. With Sansfoy was a lady calling herself Fidessa, but really the witch Duessa, daughter of Archimago, the representative of falsehood, in opposition to Una, or truth. Duessa represents herself as having been held in unwilling captivity

KILCOLMAN TOWER.

by Sansfoy, and the Red Cross Knight travels onward in her company. In the meantime Una sets out in search of her lost knight. For some time she travels alone; but one day she descends from her ass to rest in the wood.

> "It fortuned out of the thickest wood
> A ramping lion rushed suddenly,
> Hunting full greedy after savage blood.
> Soon as the royal virgin he did spy,
> With gaping mouth at her ran greedily,
> To have at once devoured her tender corse;
> But to the prey when as he drew more nigh,
> His bloody rage assuaged with remorse,
> And with the sight amazed forgot his furious force.
>
> "Instead thereof, he kissed her weary feet,
> And licked her lily hand with fawning tongue,
> As he her wronged innocence did weet
> Oh, how can beauty master the most strong,
> And simple truth subdue avenging wrong!
> Whose yielded pride and proud submission,
> Still dreading death, when she had marked long,
> Her heart gan melt in great compassion,
> And drizzling tears did shed for pure affection."

The lion becomes her protector, and with him she reaches the inhospitable cabin of Corceca, her daughter Abessa, and their confederate, Kirk-rapine, who represent the superstitions and corruptions of monasticism. Kirk-rapine is slain by the lion, and Una goes upon her way; this whole incident being manifestly an allusion to the suppression of the monasteries under Henry VIII. Una soon afterwards, partly by the guiles of Archimago, falls into the hands of Sansloy, another son of the enchanter, who carries her away.

The Red Cross Knight has been led by Duessa to the House of Pride; and the fourth canto contains an elaborate and very poetical allegorical description of the Court of Lucifera, or Pride, with the deadly sins as her attendants. Sansjoy, the third brother, comes likewise to the Court of Pride while the Red Cross Knight is there; they fight, and Sansjoy is overthrown. Duessa, to save him, visits the realms of darkness, the description of which is most powerful, and returns with the cure she sought. But she finds the Red Cross Knight departed.

We next return to Una, who is rescued from the power of Sansloy by a troop of fauns and satyrs, and a good knight Satyrane, whose history is told us; but while Satyrane and the Sarazin are fighting, the lady takes to flight in terror. In the meantime the Red Cross Knight has been rejoined by Duessa, and having drunk of an enchanted fountain, falls into the hands of the giant Orgoglio, by whom he is cast into a horrible dungeon. The dwarf, after his master's fall, goes to seek relief, and soon meets Una. They fall in with Prince Arthur, and Prince Arthur slays the giant, rescues the knight, and strips Duessa, who had become the mistress of the giant, exposing her foulness and deformity.

QUEEN ELIZABETH. (*Painted by Isaac Oliver.*)

Prince Arthur then relates his own story and his wanderings in search of the Fairy Queen, and leaves the Red Cross Knight and Una. After he has parted with them, they meet Sir Trevisa flying from Despair, and return with him to the Cave of Despair, the description of which and of Despair himself, and his arguments urging to desperation and suicide, as given in the ninth canto, are among the most remarkable passages in the whole of the "Faëry Queen." The following lines are a part of the plea for suicide:—

"What frantic fit, quoth he, has thus distraught
Thee, foolish man, so rash a doom to give?
What justice ever other judgment taught,
But he should die who merits not to live?
None else to death this man despairing drive
But his own guilty mind, deserving death.
Is then unjust to each his due to give?
Or let him die that loatheth living breath?
Or let him die at ease that liveth here uneath?

"Who travels by the weary, wandering way,
To come unto his wished home in haste,
And meets a flood that doth his passage stay;
Is not great grace to help him over past,
Or free his feet that in the mire stick fast?
Most envious man, that grieves at neighbours' good,
And fond that joyest in the woe thou hast,
Why wilt not let him pass, that long hath stood
Upon the bank? why wilt thyself not pass the flood?

"He there does now enjoy eternal rest,
And happy ease, which thou dost want and crave,
And further from it daily wanderest;
What if some little pain the passage have,
That makes frail flesh to fear the bitter wave;
Is not short pain well borne that brings long ease?
And lays the soul to sleep in quiet grave?
Sleep after toil, port after stormy seas,
Ease after war, death after life, does greatly please."

The Red Cross Knight is next led by Una to the House of Holiness, which is described in an elaborate and beautiful allegory, in which the contrast with the House of Pride is forcibly brought out. Here the knight receives purification and instruction. Thus fitted for his task, he encounters the great dragon he had come to meet, and after a three days' combat slays him. The book closes with the rejoicings over the slaughter of the dragon and the release of his victims, and with the marriage of the knight to Una.

The outline which we have given of this book will enable the student to form some idea of the character of Spenser's allegory; the detailed beauties of the poetry can be learnt only from the poem itself.

COMMERCIAL CORRESPONDENCE.—II.

[*Continued from p.* 15.]

FRENCH, GERMAN, AND ENGLISH.

9.—Reply to Letter of Inquiry as to Solvency of a Firm.

London, August 28th, 1891.

Messrs. F. Richon Bros., Lyons.

Gentlemen,—In reply to your favour of the 21st, requesting some information, we confess that the wish to avoid injuring the credit of a countryman on the one hand, and to cause you loss by incomplete information on the other, greatly embarrasses us.

The facts are thus: Messrs. Wolff & Co. have, as silk importers, enjoyed a sound reputation, but their firm has, in consequence of unforeseen circumstances (the sudden death of one of the partners, the prolonged struggle in ———, and the failure of two or three houses at Leghorn and Amsterdam), not been able to compete with others more fortunate, and has engaged, it is said, in ruinous speculations. Still, the firm's credit is sufficiently good; and if the orders are not too large (their very magnitude causing them to be suspected), you may safely execute them.

We regret not to be able to give you a more circumstantial account of the firm in question; and relying upon your discretion as to the statement contained in this letter,

We have the honour to be, Gentlemen,
Your very obedient servants,
A. J. Peters.

Londres, le 28 *août*, 1891.

Messieurs F. Richon Frères, à Lyon.

Messieurs,—En réponse à votre lettre du 21 courant, contenant une demande de renseignements, nous vous avouons que, ne désirant ni nuire au crédit d'un compatriote, ni vous occasionner de perte par des renseignements incomplets, nous nous trouvons dans un embarras extrême.

Voici les faits: Messieurs Wolff & C^{ie}, faisant l'exportation de soieries, ont joui d'une bonne réputation, mais par suite de circonstances imprévues (la mort subite d'un des associés, la durée de la guerre en ———, et la faillite de deux ou trois maisons à Livourne et à Amsterdam), la maison n'a pu soutenir la concurrence et s'est livrée, dit-on, à des spéculations ruineuses. Toutefois nous devons avouer qu'elle jouit encore d'un assez bon crédit, et si les achats ne sont pas d'une grande importance de manière à les rendre suspects, vous pouvez les exécuter en toute assurance.

Nous regrettons de ne pouvoir vous donner des détails plus circonstanciés sur la maison en question, et comptant sur votre discrétion sur ce que nous venons de dire,

Nous avons bien l'honneur
de vous saluer,
A. J. Peters.

London, 28 Auguſt, 1891.

Herren Gebrüder F. Richon, Lyon.

In Beantwortung Ihres Geehrten vom 21 curr. betreffs einer gewiſſen Auskunft müſſen wir geſtehen, daß wir uns in einem großen Dilemma befinden, indem wir weder dem Credit eines Landsmannes zu ſchaden wünſchen, noch Ihnen durch unvollſtändige Auskunft Verluſte bereiten möchten.

Der Fall liegt wie folgt. Die Herren Wolff & Co. erfreuten ſich eines guten Rufes, jedoch war ihre Firma in Folge unvorherſchener Ereigniſſe (der plötzliche Tod eines Theilhabers, der rtdauernde Krieg in ———, und der Fall von 2 oder 3 äuſern in Livorno und Amſterdam) unfähig mit anderen ücklicheren Häuſern zu concurriren, und hat ſich, wie man ſagt, iſ ruinöſe Speculationen eingelaſſen.

Immerhin iſt der Credit der Firma ein guter, und falls die uſträge nicht zu groß ſind, und dadurch gerade verdächtig ſcheinen, ſo können Sie dieſelben in aller Ruhe ausführen.

Wir bedauern Ihnen keine eingehendere Auskunft über die treffende Firma geben zu können. Indem wir uns Ihrer iscretion über unſere Mittheilungen verſichert halten, empfehlen ir uns Ihnen,

Hochachtungsvoll,
A. J. Peters.

10.—Letter proposing to Enter into Business Relations.

New Orleans, February 10th, 1891.

essrs. A. J. Smith Bros. & Co., Havre.

Gentlemen,—Mr. A. Rieu, of your city, whom we ere fortunate enough to meet in New York, spoke high terms of your firm, and assured us that we ould not entrust our affairs to better hands than our own. We hasten, therefore, on Mr. Rieu's ecommendation, to ask you if it will suit you to eceive our consignments of tobacco and cotton, nd take upon yourselves equally the liquidation f our engagements to the value of the goods so nt

Should you accept our proposition, be good nough to send us a *pro formâ* account sale, in rder that we may have some notion of the expenses and usages of your place.

We are, Gentlemen,
Most obediently yours,
Lewis Frisby, McHenry & Co.

La Nouvelle-Orléans, le 10 février, 1891.

essieurs A. J. Smith Frères & C^{ie}, au Hâvre.

Messieurs,—M. A. Rieu de votre ville, que nous vons eu le plaisir de voir à New-York, en nous isant l'éloge de votre loyauté en affaires, nous a ssurés que nous ne pouvions mieux confier nos ntérêts qu'à vous. Nous nous hâtons donc, sur la ecommandation de M. Rieu, de vous demander s'il ous conviendrait de recevoir nos consignations de abac et de coton, et de vous charger également de acquit d'engagements pour une somme équivalente la valeur de nos envois.

Si vous acceptez notre proposition, veuillez bien, essieurs, nous remettre un compte de vente *simulé*, fin que nous puissions nous rendre compte des frais t usages de votre place.

Agréez, Messieurs,
l'assurance de notre parfaite considération,
Lewis Frisby, McHenry & C^{ie}.

Neu-Orleans, 10 Februar, 1891.

Herren Gebrüder A. J. Smith & Co., Havre.

Herr A. Rieu, von dort, den ich in New-York zu treffen das Vergnügen hatte, ſprach von Ihrer werthen Firma in ſehr anerkennender Weiſe, und verſicherte uns, daß wir unſere Intereſſen in keine beſſeren Hände als die Ihrigen, legen könnten. Wir beeilen uns daher auf Herrn Rieu's Empfehlung hin bei Ihnen anzufragen, ob es Ihnen genehm iſt unſere Conſignationen von Tabak und Baumwolle zu erhalten und gleichzeitig den Vertrieb unſerer Sendungen zu facturirten Werthen zu übernehmen.

Falls Sie unſern Vorſchlag annehmen, ſo wollen Sie uns eine Proforma Verkaufsrechnung ſenden, damit wir uns ein Bild über die Unkoſten und die Gebräuche Ihres Platzes machen können.

Wir empfehlen uns hochachtungsvoll,
Lewis Frisby, McHenry & Co

11.—Letter proposing the Opening of an Account.

Havre, March 20th, 1891.

Messrs. Lewis Frisby, McHenry & Co.,
New Orleans.

Gentlemen,—We have to acknowledge the receipt of your favour of the 10th of February, and hasten to reply.

We willingly accept your proposals, and shall be delighted to see relations established between our two houses that may prove mutually advantageous. You may rest assured that we will do all in our power to merit the good opinion with which Mr. Rieu has inspired you, and to show ourselves worthy of the confidence reposed in us.

We hasten to satisfy your wishes by sending you enclosed a *pro formâ* account sale, that may serve you as a basis for future operations. Our terms are 2 per cent. commission, and 2 per cent. *delcredere.*

We shall be ready to make advances to the extent of two-thirds of the invoice amount of goods consigned to us for sale on receipt of invoice, bills of lading, and orders for insurance.

It is unnecessary to observe that we shall send you accounts of the state of the market by all the boats leaving for New Orleans.

We remain, Gentlemen,
Your very obedient servants,
A. J. Smith Bros. & Co.

Le Havre, le 20 mars, 1891.

Messieurs Lewis Frisby, McHenry et C^{ie},
à la Nouvelle-Orléans.

Messieurs,—Nous accusons réception de votre honorée en date du 10 février et nous empressons d'y répondre.

Nous acceptons vos propositions avec empressement, et nous serons charmés de voir s'établir entre nos deux maisons des rapports suivis et réciproque-

"What frantic fit, quoth he, has thus distraught
Thee, foolish man, so rash a doom to give?
What justice ever other judgment taught,
But he should die who merits not to live?
None else to death this man despairing drive
But his own guilty mind, deserving death.
Is then unjust to each his due to give?
Or let him die that loatheth living breath?
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"Who travels by the weary, wandering way,
To come unto his wished home in haste,
And meets a flood that doth his passage stay;
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Most envious man, that grieves at neighbours' good,
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The Red Cross Knight is next led by Una to the House of Holiness, which is described in an elaborate and beautiful allegory, in which the contrast with the House of Pride is forcibly brought out. Here the knight receives purification and instruction. Thus fitted for his task, he encounters the great dragon he had come to meet, and after a three days' combat slays him. The book closes with the rejoicings over the slaughter of the dragon and the release of his victims, and with the marriage of the knight to Una.

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COMMERCIAL CORRESPONDENCE.—II.

[*Continued from p.* 15.]

FRENCH, GERMAN, AND ENGLISH.

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10.—Letter proposing to Enter into Business Relations.

New Orleans, February 10th, 1891.
Messrs. A. J. Smith Bros. & Co., Havre.

Gentlemen,—Mr. A. Rieu, of your city, whom we were fortunate enough to meet in New York, spoke in high terms of your firm, and assured us that we could not entrust our affairs to better hands than your own. We hasten, therefore, on Mr. Rieu's recommendation, to ask you if it will suit you to receive our consignments of tobacco and cotton, and take upon yourselves equally the liquidation of our engagements to the value of the goods so sent.

Should you accept our proposition, be good enough to send us a *pro formâ* account sale, in order that we may have some notion of the expenses and usages of your place.

We are, Gentlemen,
Most obediently yours,
Lewis Frisby, McHenry & Co.

La Nouvelle-Orléans, le 10 *février*, 1891.
Messieurs A. J. Smith Frères & Cie, au Hâvre.

Messieurs,—M. A. Rieu de votre ville, que nous avons eu le plaisir de voir à New-York, en nous faisant l'éloge de votre loyauté en affaires, nous a assurés que nous ne pouvions mieux confier nos intérêts qu'à vous. Nous nous hâtons donc, sur la recommandation de M. Rieu, de vous demander s'il vous conviendrait de recevoir nos consignations de tabac et de coton, et de vous charger également de l'acquit d'engagements pour une somme équivalente à la valeur de nos envois.

Si vous acceptez notre proposition, veuillez bien, Messieurs, nous remettre un compte de vente *simulé*, afin que nous puissions nous rendre compte des frais et usages de votre place.

Agréez, Messieurs,
l'assurance de notre parfaite considération,
Lewis Frisby, McHenry & Cie.

Neu-Orleans, 10 Februar, 1891.
Herren Gebrüder A. J. Smith & Co., Havre.

Herr A. Rieu, von dort, den ich in New-York zu treffen das Vergnugen hatte, ſprach von Ihrer werthen Firma in ſehr anerkennender Weiſe, und verſicherte uns, daß wir unſere Intereſſen in keine beſſeren Hände als die Ihrigen, legen könnten. Wir beeilen uns daher auf Herrn Rieu's Empfehlung hin bei Ihnen anzufragen, ob es Ihnen genehm iſt unſere Conſignationen von Tabak und Baumwolle zu erhalten und gleichzeitig den Vertrieb unſerer Sendungen zu facturirten Werthen zu übernehmen.

Falls Sie unſern Vorſchlag annehmen, ſo wollen Sie uns eine Proforma Verkaufsrechnung ſenden, damit wir uns ein Bild über die Unkoſten und die Gebräuche Ihres Platzes machen können.

Wir empfehlen uns hochachtungsvoll,
Lewis Frisby, McHenry & Co.

11.—Letter proposing the Opening of an Account.

Havre, March 20th, 1891.
Messrs. Lewis Frisby, McHenry & Co.,
New Orleans.

Gentlemen,—We have to acknowledge the receipt of your favour of the 10th of February, and hasten to reply.

We willingly accept your proposals, and shall be delighted to see relations established between our two houses that may prove mutually advantageous. You may rest assured that we will do all in our power to merit the good opinion with which Mr. Rieu has inspired you, and to show ourselves worthy of the confidence reposed in us.

We hasten to satisfy your wishes by sending you enclosed a *pro formâ* account sale, that may serve you as a basis for future operations. Our terms are 2 per cent. commission, and 2 per cent. *delcredere.*

We shall be ready to make advances to the extent of two-thirds of the invoice amount of goods consigned to us for sale on receipt of invoice, bills of lading, and orders for insurance.

It is unnecessary to observe that we shall send you accounts of the state of the market by all the boats leaving for New Orleans.

We remain, Gentlemen,
Your very obedient servants,
A. J. Smith Bros. & Co.

Le Havre, le 20 *mars*, 1891.
Messieurs Lewis Frisby, McHenry et Cie,
à la Nouvelle-Orléans.

Messieurs, — Nous accusons réception de votre honorée en date du 10 février et nous empressons d'y répondre.

Nous acceptons vos propositions avec empressement, et nous serons charmés de voir s'établir entre nos deux maisons des rapports suivis et réciproque-

ment fructueux. Croyez bien que nous ferons tout ce qui dépendra de nous pour répondre dignement à l'opinion que M. Rieu vous a inspirée et à la confiance dont vous voulez nous honorer.

Nous nous empressons de satisfaire à vos désirs en vous remettant sous ce pli le compte de vente *simulé* que vous nous demandez, afin qu'il puisse vous servir de base pour vos opérations futures. Nos conditions sont : 2 pour cent de commission et 2 pour cent de *ducroire.*

Nous sommes prêts à faire des avances pour les deux tiers du montant des consignations qui nous seront adressées en recevant facture, connaissement et l'ordre de faire l'assurance.

Inutile de vous dire que nous profiterons de tous les navires en partance pour la Nouvelle-Orléans pour vous tenir au courant de l'état de notre marché.

Agréez, Messieurs,
l'assurance de notre estime,
A. J. SMITH FRÈRES & C$^{\text{ie}}$.

Havre, 20 März, 1891.

Herren Lewis Frisby, McHenry & Co., Neu-Orleans.

Wir bekennen uns zum Empfang Ihres Werthen vom 10 Februar, und beeilen uns, daſſelbe zu beantworten.

Wir nehmen Ihre Vorſchläge mit Vergnügen an und werden uns ſehr freuen, wenn ſich zwiſchen unſern Häuſern allſeitig vortheilhafte Beziehungen entwickeln ſollten. Sie dürfen überzeugt ſein, daß wir Alles aufbieten werden, um die gute Meinung zu verdienen, welche Herr Rieu in Ihnen hervorgerufen hat, und um uns des in uns geſetzten Vertrauens würdig zu zeigen.

Wir beeilen uns Ihnen in Übereinſtimmung mit Ihren Wünſchen anliegend eine Proforma Abrechnung zu ſenden, welche als Baſis für kommende Operationen dienen mag. Unſere Bedingungen ſind 2 Procent Commiſſion und 2 Procent Delcredere.

Wir ſind bereit zu Vorſchüßen bis zur Höhe von zwei Dritteln des Facturenbetrages von Waren die uns zum Verkauf conſignirt werden, bei Empfang von Factura, Ladeſchein und Verſicherungs-Order.

Wir werden Ihnen ſelbſtredend mit jedem nach Neu-Orleans gehenden Boote Berichte über die Marktlage ſenden.

Hochachtungsvoll,
Gebrüder A. J. Smith & Co.

12.—A LETTER ADVISING THE EXECUTION OF AN ORDER.

Cognac, May 10th, 1891.

Messrs. J. Ellison, Wine Merchants, London.

Gentlemen,—In pursuance of the order contained in your letter of the 15th of April, and in accordance with the prices and conditions laid down, I have bought for your account 20 tierces of brandy, 27 degrees, and forwarded them to your brother in Paris. Enclosed you will find the invoice, amounting to 30,760 francs, with which I debit you. In conformity with your wishes, I have drawn this day on your account, on Messrs. J. Lafitte, of Paris, at three months, payable to my order, for the above amount.

I wrote to you on the subject of your account with me at length in my last, and have nothing more to add.

I remain, Gentlemen,
Your very obedient servant,
FRANCIS MARTIN.

Cognac, le 10 *mai*, 1891.

Messieurs J. Ellison, Négociants en Vins,
à Londres.

Messieurs,—En exécution de l'ordre contenu dans votre honorée du 15 avril, j'ai acheté aux prix et conditions y fixés, pour votre compte, 20 tierçons eau-de-vie, 27 degrés, et je les ai expédiés à M. votre frère à Paris. Vous en trouverez sous ce pli la facture, s'élevant à 30,760 francs, portés à votre débit. Pour me conformer à vos désirs, je viens de disposer pour votre compte, sur MM. J. Lafitte, de Paris, ma traite en date de ce jour pour la dite somme, à mon ordre, payable à trois mois.

Je me suis étendu dans ma dernière au sujet de votre compte chez moi, et je n'ai rien à ajouter à mes observations.

J'ai l'honneur d'être, Messieurs,
Votre très-humble serviteur,
FRANCIS MARTIN.

Cognac, 10 Mai, 1891.

Herren J. Elliſon, Weinhändler, London.

Laut dem mir mit Ihrer geehrten Zuſchrift vom 15 April ertheilten Auftrage, und in Übereinſtimmung mit vorgeſchriebenem Preiſe und Bedingungen kaufte ich für Ihre werthe Rechnung 20 Drittelpipen Branntwein, von 27 Grad, welche ich an Ihren Herrn Bruder in Paris expedirt habe. Anbei beehre ich mich Ihnen Factura in Betrage von fr. 30,760 zu Ihren Laſten zu überreichen. Ihren Wünſchen entſprechend habe ich obigen Betrag heute für Ihre Rechnung auf Herren J. Lafitte in Paris in meiner Dreimonats Tratte, an meine Order, entnommen

Ich ſchrieb Ihnen in meinem ergebenen Letzten ausführlich über Ihr Conto bei mir, und zeichne ohne mehr für heute,

Achtungsvoll ergeben.
Francis Martin.

13.—LETTER EMBODYING AN OFFER OF SERVICES AS CLERK.

Metz, March 15th, 1891.

E. Merle, Esq., London.

Sir,—I take the liberty, upon recommendation of Mr. Lecouteur, with whom I have been working the last five years, of writing to offer you my services. My only motive for quitting a firm to which I owe much, and for seeking a situation abroad, is the desire of extending my knowledge of business and of perfecting myself in a language, the rudiments of which I know already.

Having been engaged for three years in book-keeping, I have during the last two years filled the post of English and German correspondent. At the same time I have devoted my attention to the study of the Exchange, and I venture to hope that I should satisfactorily discharge the duties of correspondent or ledger-clerk.

As regards my position in this firm, I beg to refer you to Mr. Lecouteur, who has kindly promised to write to you on my behalf.

No further assertion on my part is necessary as to my doing my best to merit the confidence reposed in me.

Be so kind as to favour me with a reply; and should there be no vacancy in your firm, let me know what chances there are of obtaining a post among your friends,

And believe me, Sir,
Your very obedient and humble servant,
A. Wolff.

Metz, le 15 *mars*, 1891.

Monsieur E. Merle, à Londres.

Monsieur. — C'est sur la recommandation de Monsieur Lecouteur, chez qui je travaille depuis plus de cinq ans, que je prends la liberté de vous écrire pour vous offrir mes services. Le désir d'étendre mes connaissances commerciales et de me rendre plus familière une langue dont les principes me sont déjà connus, peut seul me déterminer à quitter une maison à laquelle je dois beaucoup, pour chercher une place à l'étranger.

Je me suis occupé pendant trois ans de la tenue des livres, j'ai été chargé ensuite pendant les deux dernières années de la correspondance en anglais et en allemand. J'ai donné toute mon attention à l'étude du change, et j'ose me flatter que je pourrais acquitter à votre satisfaction des fonctions qui se rattacheraient à la correspondance ou à la partie des comptes-courants.

Quant à ma position dans cette maison, je m'en réfère au témoignage de Monsieur Lecouteur, qui m'a promis de vous écrire en ma faveur.

Je ne dis mot sur le fait que je ferai de mon mieux pour justifier la confiance dont on aura bien voulu m'honorer.

Veuillez, je vous prie, m'honorer d'une réponse, et en cas où il n'y aurait pas de place chez vous, de me faire savoir s'il y aurait la chance d'en obtenir une chez un de vos amis, et agréer l'assurance de l'estime avec laquelle,

J'ai l'honneur d'être, Monsieur,
Votre très-humble et très-obéissant serviteur,
A. Wolff.

Metz, 15 März, 1891.

Herrn E. Merle, London.

Ich bin ſo frei, auf die Empfehlung von Herrn Lecouteur hin, bei welchem ich während der letzten fünf Jahre gearbeitet habe, Ihnen hiermit meine Dienſte anzubieten. Der Wunſch meine Geſchäftskenntniſſe zu erweitern und mich in einer Sprache zu üben, deren Grundzüge mir bereits bekannt, iſt der einzige Grund zum Verlaſſen einer Firma, der ich ſo viel ſchulde, und zum Verſuche eine Stellung im Auslande zu finden.

Nachdem ich während drei Jahren mit der Buchhaltung beſchäftigt war, verſah ich in den letzten zwei Jahren den Poſten eines engliſchen und deutſchen Correſpondenten. Gleichzeitig widmete ich dem Studium der Curſe beſondere Aufmerkſamkeit und ich wage zu hoffen, daß ich die Arbeiten eines Correſpondenten oder Buchhalters zur Zufriedenheit erledigen würde.

Betreffs meiner Stellung in dieſer Firma erlaube ich mir mich auf Herrn Lecouteur zu beziehen, der mir gütigſt verſprochen hat meinetwegen an Sie zu ſchreiben.

Ich brauche kaum zu erwähnen, daß ich mein Beſtes thun würde um das mir geſchenkte Vertrauen zu verdienen.

Ich erſuche Sie um gefällige Antwort, und für den Fall daß Sie keine Vacanz in Ihrer werthen Firma haben ſollten, theilen Sie mir bitte mit, ob Sie Ausſichten haben, mir bei einem Ihrer Freunde eine Stellung zu verſchaffen.

Ich verbleibe mit vorzüglichſter
Hochachtung ergebenſt,
A. Wolff.

14.—Letter on Transfer of Order or Commission.

Philpot Lane, London, Feb. 10th, 1891.

Messrs. Martin and Co., Boulogne.

Gentlemen,—We beg to forward you a letter just received from Mons. Achard, of Dieppe. You are in a better position to undertake this little matter. Will you undertake it?

We are, Gentlemen, most truly yours,
Smith Bros.

Philpot Lane, Londres, 10 *février*, 1891.

Messieurs Martin et C^ie^, à Boulogne.

Messieurs,—Nous avons l'honneur de vous adresser une lettre que nous recevons de Monsieur Achard, à Dieppe. Vous êtes mieux placés que nous pour traiter cette petite affaire. Vous convient-il de vous en charger?

Agréez, Messieurs,
nos cordiales salutations,
Smith Frères.

Philpot Lane, London, 10 Februar, 1891.

Herren Martin und Co., Boulogne.

Wir beehren uns, Ihnen einliegend einen Brief zu überſenden, den wir ſoeben von Herrn Achard in Dieppe erhielten. Sie ſind eher in der Lage als wir, dies kleine Geſchäft zu machen. Wollen Sie es in Hand nehmen?

Hochachtungsvoll,
Gebrüder Smith.

15.—Letter sending First Order to a Firm.

Bremen, *February* 1st, 1891.

Monsieur A. de Carvalho, Trinidad.

Sir,—Your firm has been recommended to me by a friend as one of the best and promptest in executing its correspondents' orders; I should, therefore, be glad to enter into business relations with you. I beg you to send me, by the first vessel sailing from your port to Bremen, the following goods:—

16 barrels of Virginia leaves, first quality;
15 barrels of new Carolina rice;
50 barrels of raw sugar.

As I have not the pleasure of being known to you, I beg to refer you for all information you may desire to Mr. Aguilar, of your city, an old friend of mine, or to Messrs. Andrada, the bankers.

You may draw, for the amount, upon Messrs. Julius Gerstenberg and Co., of London, who have received my orders to accept your drafts.

I am, Sir,
Your obedient servant,
Jacques Lemaître.

Bremen, *le* 1er *février*, 1891.

Monsieur A. de Carvalho, Île de la Trinité.

Monsieur,—Un de mes amis m'a recommandé votre maison comme une des plus solides et des plus exactes à exécuter les commissions de ses commettants; je serais donc bien aise d'entrer en relation avec vous. Je vous prie de m'envoyer par le premier navire qui partira de chez vous pour Bremen les marchandises suivantes, savoir:—

16 barriques de feuilles de Virginie, première qualité;
15 barriques ris nouveau, de la Caroline;
50 tonneaux de sucre brut.

Comme je n'ai pas l'honneur d'être connu de vous, vous pourrez prendre des informations sur mon compte, soit chez M. Aguilar de votre ville, mon ancien ami, qui vous fixera sur le degré de confiance que je mérite, soit chez Messieurs Andrada, banquiers.

Vous pouvez tirer pour le montant sur Messieurs Julius Gerstenberg et Cie, de Londres, qui ont reçu ordre d'accepter vos traites.

Agréez, Monsieur,
Mes civilités empressées,
Jacques Lemaître.

Bremen, 1 Februar, 1891.

Herr A. de Carvalho, Trinidad.

Ihre Firma wurde mir als eine der beſten und prompteſten Firmen zur Ausführung der Aufträge von Geſchäftsfreunden empfohlen, und es würde mir daher angenehm ſein, in Geſchäftsverbindung mit Ihnen zu treten. Ich bitte Sie mir per erſten Segler von Trinidad nach Bremen folgende Waren zu ſenden:—

16 Faß Virginia Blätter, Prima Qualität.
15 Faß Neuer Carolina Reis.
50 Faß Rohzucker.

Da ich nicht das Vergnügen Ihrer Bekanntſchaft genieße, ſo verweiſe ich Sie betreffs jeder gewünſchten Auskunft an Herrn Aguilar dort, der ein alter Freund von mir iſt, oder an die Banquiers Herren Andrada.

Sie können den Betrag auf Herren Julius Gerſtenberg und Co. in London entnehmen, welche von mir beauftragt wurden Ihre Tratten zu acceptiren.

Hochachtungsvoll,
Jacques Lemaitre.

ARCHITECTURE.—V.

[*Continued from p.* 22.]

THE BYZANTINE STYLE.

The term Byzantine is employed to define the round-arched architectural style which was formed and developed in the East, as distinguished from the Romanesque (also a round-arched style), the term given to its development in the West of Europe.

The first formation, the archaic period, so to speak, commences in 324 A.D., when Constantine transferred the seat of his empire to Constantinople. Its culmination or highest development was reached under Justinian, who, in 532–58 A.D., built St. Sophia at Byzantium, now known as Constantinople (Figs. 14, 15, 16); and that church, now used as a mosque by the Turks, in the arrangement of its plan and in the principles of its construction has become the typical form of the Greek church down to the present day.

It is difficult in the early ages of any new style, which is based on preceding and contemporaneous work, to draw any hard and fast line of demarcation. Even in Rome herself great changes had been taking place in the Roman style; and the arch was gradually taking the place of the lintel, or was formed in the frieze above an architrave to take off from the latter the weight of the superstructure.

In the great palace built by Diocletian at Spalato in Dalmatia, where he retired from the cares of empire in 284 A.D., we find numerous indications of impending changes. The architrave or lintel of the Golden Gate is no longer a single stone, but a series of voussoirs forming what is known as a flat arch, and the pressure on this is relieved by throwing across above it what is known as a relieving arch. Again, in one of the courtyards of the palace, in order to obtain a wider opening in the centre of the portico leading to the palace, an arch is thrown across the opening instead of an architrave, and the mouldings of architrave, frieze, and cornice are carried round this arch. In the portico on each side also, the semi-detached shaft and imposts are dispensed with, and the arch is carried direct on the capital and shaft of a column. The same arrangement is found in the Roman gateway leading to the Mosque of Damascus. Even, however, before this, in Syria the germs of a new style had been developing themselves—possibly the work of Greek artists who migrated into that country after the Roman conquest; and we find in the tombs of the kings and of the prophets at Jerusalem decadent forms of Greek art, particularly in the carving of foliage and ornament, which approaches in its treatment more to Byzantine than to ancient Greek work. In Central Syria, in the cities of the Hauran, deserted since the 6th century, and in the vicinity of Aleppo the researches of M. de Vogüé have made us acquainted with a large number of cities, the churches and houses in which, all built in stone, have been preserved to our day, and show clearly that at the time of the transfer of the empire, and probably a century earlier, the elements of a new style had been in formation for some time.

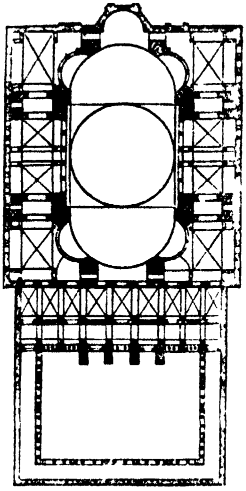
Fig. 14.—Ground Plan of St. Sophia, Constantinople.

Constantine, when he transferred his empire, found himself in presence of two difficulties: 1stly, the want of intelligent artists and good workmen; and 2ndly, time to carry out the stupendous undertaking he had in hand, viz., to create a new city which should rival Rome in the splendour of its churches and palaces. His attention, however, was not confined to Byzantium, for at Jerusalem he erected the first church of the Holy Sepulchre; at Bethlehem, the church of the Nativity; and throughout the Holy Land structures of various kinds, chiefly devoted, however, to those buildings which were to be erected for the purposes of the new faith to which he had become a convert.

Constantine's works in Byzantium were not confined to churches; he is reported to have introduced amphitheatres, palaces, *thermæ*, and other public buildings. Owing however to the undue haste with which they were built, to the destructibility of the material—for they were chiefly roofed with timber—and to the want of proper skill in their erection, they speedily fell into ruins and had to be rebuilt by his successors. One basilica only at Bethlehem exists, and this and the description given by Eusebius—a writer of the period—give us some clue as to the nature at least of the churches he had projected. As a type of church which could be the most easily erected and which would hold the largest congregation, he adopted the plan of that which is known as a basilica, a building consisting of a nave and aisles on all sides, and a semi-circular recess or apse at one end in which the courts of justice were established. Instead of being separated from the nave of the church, as the court of justice had been, by aisles, the apse was opened to it through a large arch. Furthermore it was raised so that the altar and the priest could be seen from the whole interior. In front of the church he provided a cross vestibule or narthex for the penitents, and in front of this again an open court with portico or arcade round and a fountain for ablutions in its midst.

Of the church at Bethlehem there exist only the nave and aisles, the transept and choir having been probably rebuilt by Justinian. The columns have lost much of the grace of the Roman variety, and the capitals are coarsely carved as if in recollection only of what the artists had seen or heard of in Rome. Of the Holy Sepulchre nothing remains probably but the lower portion of the rock and sepulchre which Constantine believed to be the last resting-place of our Lord—possibly the foundations

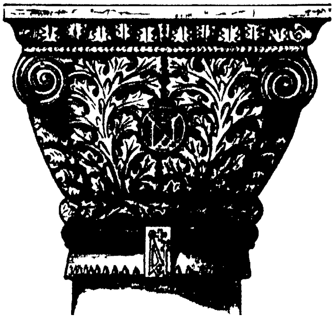
Fig. 15.—Capital from St. Sophia, Constantinople.

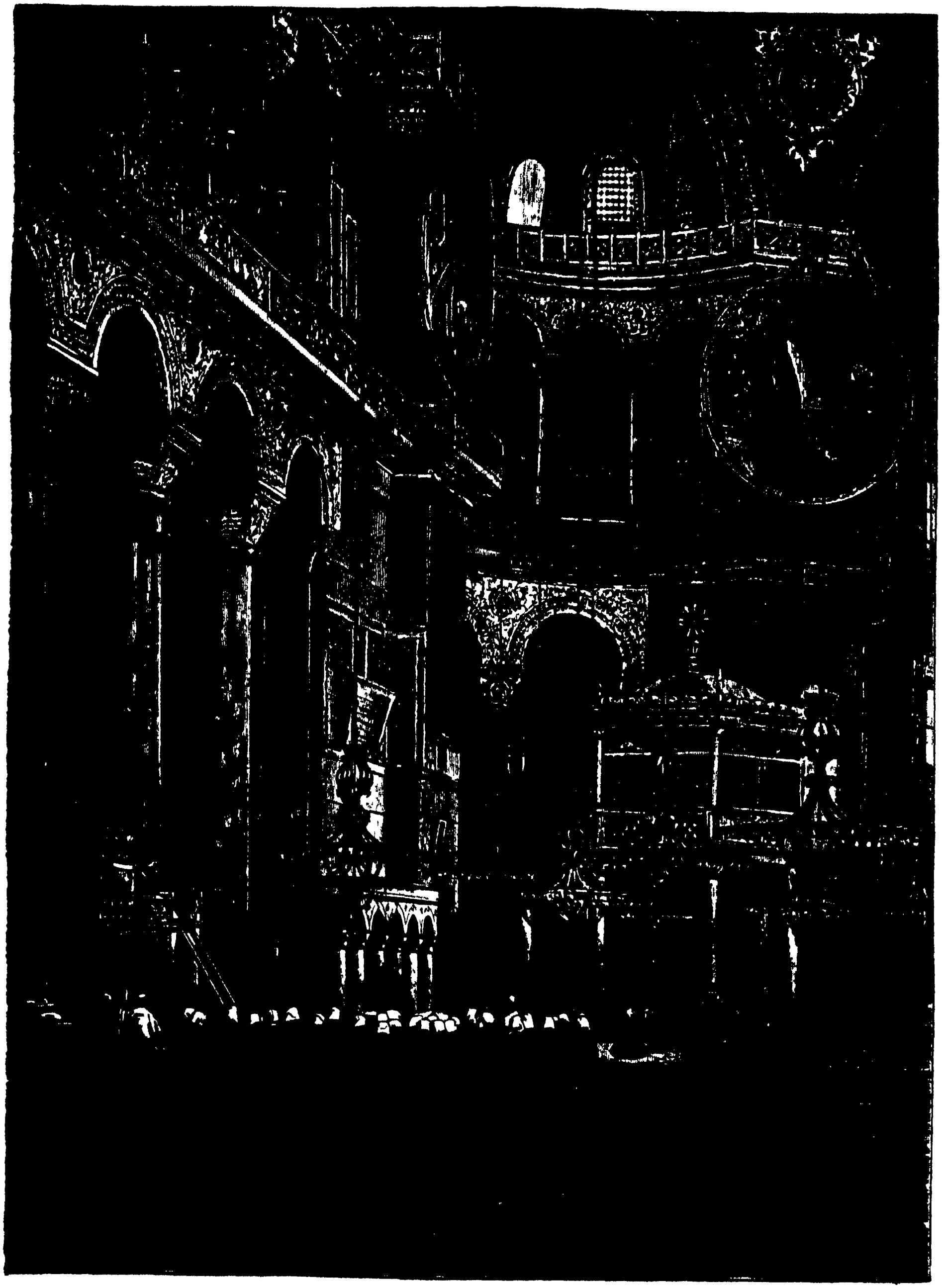

Fig. 16.—Interior of St. Sophia, Constantinople.

of the great columns he raised round it—and the rock-cut apse which he cut away in order to isolate the sepulchre in its midst.

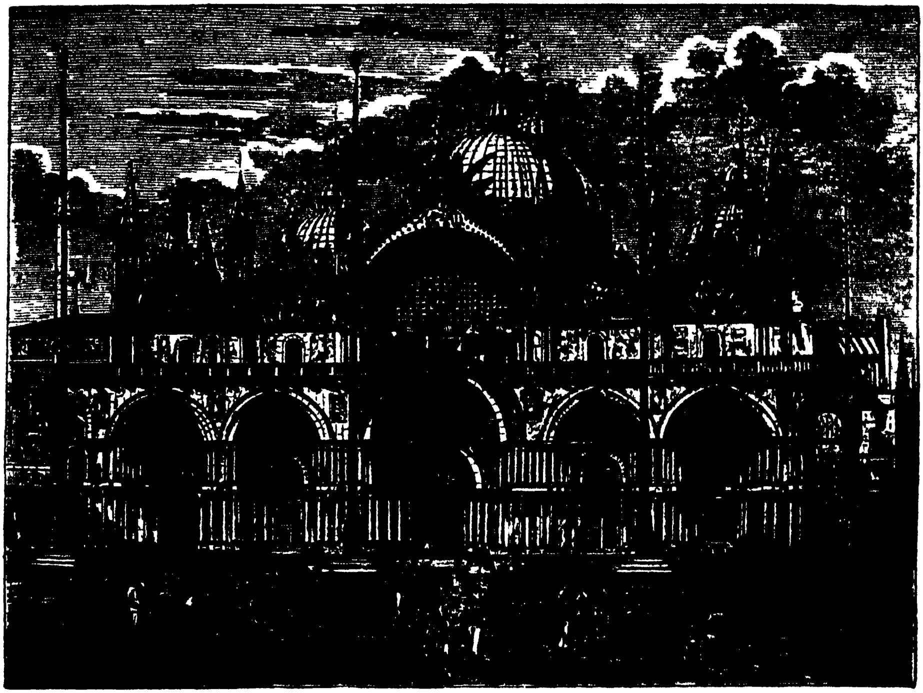

Fig 17.—St. Mark's, Venice.

The next typical Byzantine example in point of date is the church of St. Demetrius at Thessalonica, a basilican church with atrium and fountain, narthex, nave, and double aisles, with capacious galleries on the first floor for women—an apsidal termination to the nave and two atria, one on each side of the sanctuary. Whilst at Bethlehem the aisles are separated from the nave by columns carrying architraves which carry the wall above, here in St. Demetrius we notice the first important change—arches, both on the ground and first floor of the galleries, have taken the place of the architrave. These arches are carried on columns with capitals, but between them and the arch exists a new feature which is typical of Byzantine work, and is known as the dosseret; it is probably derived from that fragment of the entablature which the Romans considered to be the necessary complement of the column, and which they placed above the capital though it served no constructional purpose. The dosseret, however, had a constructional value; projecting beyond the capital on either side, it enabled the springing of arches to be carried on the cap without their being made too small. The nave and aisles were in this example roofed over in timber, as we have seen was the custom in early Roman basilicas. The last Roman basilica erected in Rome, it will be remembered, was that of Maxentius in the Forum, and this was vaulted over similar to the tepidarium in the Roman baths. Structures of this kind, however, required great scientific skill, and they took some time to build. The only vaulted portion of the Byzantine basilicas which Constantine built was the apse, and the next step taken was to introduce the vault over the whole church, so that it should be at all events rendered indestructible by fire.

We come now, therefore, to the great work which Justinian erected, the church of St. Sophia at Constantinople (Figs. 14, 15, 16). The two centuries which had elapsed since Constantine's time are virtually a blank so far as vaulted constructions are concerned. We may notice in passing in

Ravenna the tomb of Galla Placidia, now the church of St. Nazarius and Celso, built 450 A.D., which resembles somewhat the description of a church which is said to have been built by Constantine at Constantinople; but it is very small, measuring internally 35 feet by 30 feet. Supposing, however, that its dimensions were increased so as to make it of the size of the vaulted hall of Maxentius and the Pantheon, the crossing of these two types would produce such a building as that which we find in St. Sophia. There is, however, one other building in Constantinople which may be taken as the immediate step-stone, viz.: the church of St. Sergius and Bacchus known as the lesser St. Sophia, and which was erected just before the greater church. The problem solved in this church was the placing of a dome on an octagonal building. Arches forming recesses were thrown across the eight sides of the octagon and on their haunches, or on the extrados of the voussoirs, a feature called a pendentive was formed, which rose to a circle on which the dome was built. The problem of St. Sophia was much more difficult, the architects there, Anthemius of Tralles, and Isodoros of Miletus, had to carry a dome on four arches, and as the dome was 107 feet in diameter the pendentives had to be of immense size. The four arches enclosed a square on plan, the pendentives were required to overhang until the plan was reduced to the form of a circle on which the dome was built. The form taken by these pendentives was that of a sphere, the radius of which was equal to half the diagonal of the square. With the same radius it might have been possible to complete the dome, and it is possible this was done at first: twenty years after its erection, however, in 558, a portion of the dome was overthrown by an earthquake, and the new dome was raised, the lower portion being pierced with forty circular-headed windows to light the interior. The actual effect of the dome is now as described by Procopius, a writer of Justinian's time who witnessed its erection, "as if it were suspended by a chain from heaven."

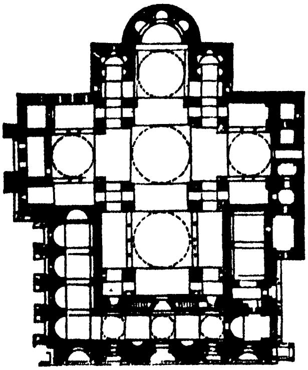

Fig. 18.—Ground Plan of St. Mark's, Venice.

The general plan of the building is that of an oblong square, the dome in the centre, two enormous apses at the east and the west end which open outwards from two of the great arches carrying the dome. The other two are filled in with walls supported on arcades on two storeys, and with wide aisles beyond them. In front of the building is a huge narthex preceded by an open court or atrium. The church is lighted by the windows in the dome, by windows above the aisles on each side, and by windows in the apses and in the side walls. The lower portion is panelled with marble, and the whole of the upper part and dome is lined with mosaics which, as they contain figure subjects forbidden by the Mohammedan religion, are now covered over with stucco and painted. When the church was restored twenty years ago, these were drawn and published, and the whole discreetly covered up again to prevent their being otherwise destroyed by the Turks. Words would fail to describe the extraordinary beauty of the building, and its immense apparent size, and we çan well understand the reality of Justinian's boast, who, when it was completed, is recorded to have said, "at last I have vanquished thee, O Solomon": if he had known what Solomon's temple was, he would probably have been still more exultant.

The church of St. Sophia was not only the finest of its kind at the time of its erection, but nothing approaching it has ever been built since in the Byzantine style. Some of the mosques erected by the Turks, to which we shall refer again, constitute some of the finest works of the Mohammedans; but the builders of the Greek churches erected since, whilst they accept St. Sophia's as a model, have never attempted domes of more than 40 feet span, and the chief modification introduced since has been to raise the dome on a cylindrical drum pierced with windows, which with other smaller domes round makes a more picturesque exterior than St. Sophia's. The domes in these subsequent examples being so much smaller, it became necessary to obtain space in another way, and this was done by increasing the area beyond the arches carrying the dome in the four directions, so that the church took the plan of a Greek cross.

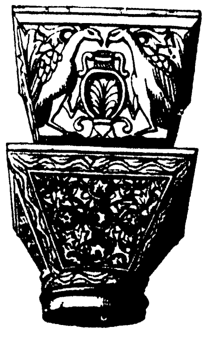

Fig. 19.—Capital from St. Vitale, Ravenna.

It is this arrangement of plan which was adopted in the tenth and eleventh centuries for the church of St. Mark's at Venice, said to have been copied from St. Mark's at Alexandria, and which betrays, throughout, its Byzantine origin: here the projecting limbs were made equal in size to the crossing, and were surmounted each by a dome. The decorative marbles there employed were principally taken from other buildings in the East, and the interior is lined with mosaics which still constitute the great glory of that building.

In Ravenna, also in Italy, we come again to Byzantine work, and in the church of St. Vitale we have a church which bears a certain resemblance to St. Sergius and Bacchus already referred to, viz., a dome carried on eight arches. In the churches of St. Apollinare in Classe, St. Apollinare Nuovo, both in or near Ravenna, we have two churches of the basilican type whose walls and apse are covered with Byzantine mosaic.

The influence of Byzantium was felt in many parts of Italy and Sicily, its mosaics are found in many of the older basilican churches of Rome, and even in a portion of France, at St. Front de Perigueux, and in the domed churches of the Charente, we find domes all of which were indirectly derived (probably from the settlement of Greek artists) from Byzantium or Venice, for the church of St. Front is more or less a reproduction of St. Mark's at Venice.

POLITICAL ECONOMY.—I.

POLITICAL ECONOMY, ITS CHARACTER, NAME, AND METHOD — PRELIMINARY NOTIONS — WEALTH AND VALUE.

POLITICAL ECONOMY is the science which investigates the nature of wealth, and the laws which govern its production, exchange, and distribution. Wealth is any material thing which has an exchange value—that is, which people desire sufficiently to be willing to give something in exchange for it.

The broad distinction between a science and an art is that a science tells us what happens under certain given conditions, and an art tells us what we ought to do—what conditions we must produce —if we want to effect a certain object. Every art, therefore, is based on science; but generally the conditions are so complex that it has to take into account several sciences, besides much knowledge which is not yet systematic enough to be called science. Thus the art of the engineer who designs a bridge implies considerable knowledge of the sciences of mathematics and physics and of the chemistry of the materials he employs; as well as a number of special circumstances affecting this particular bridge—the nature of the ground in which the foundations are to be laid, the probable strain it will have to bear, sometimes the force of the winds it may have to resist, and so on.

Most sciences, if not all, have begun in arts; that is, knowledge was systematised for practical purposes before it was cultivated for its own sake. Geometry, for instance, grew up out of land-surveying, chemistry partly out of the art of medicine, partly out of alchemy, which was an attempt at an art of transmuting metals. Political economy, as its name shows, has had a similar origin. "Economy," from a Greek word meaning the management of a household, came to mean the art of managing the means and resources on which the household depended for its subsistence. The Greek word is thus used by Aristotle. Political economy came to mean the same kind of art applied to the means and resources of the nation. It was supposed to teach in what way a government can best promote the increase of the aggregate wealth of the nation. Adam Smith uses the term in this sense. His great work, "The Wealth of Nations," first published in 1783, was primarily an elaborate attack on the policy pursued up to that time by most European governments—known as the "Mercantile System" —of managing and controlling the wealth of the nation. We shall recur to this system presently. But Adam Smith opened up so many questions by his inquiry into the circumstances which are most favourable to the increase of the national wealth that since his time the conditions affecting the production, distribution, and exchange of wealth (which, as we shall see, are to a great extent dependent upon one another) have been studied separately, as far as possible, from the practical business of promoting the increase of the wealth of a nation.

Now, as a science, political economy is purely theoretical. It does not tell how to get wealth, nor does it decide what are the best systems of production, distribution, and exchange. It does not decide between the system of large estates and peasant proprietors; between private ownership of the means of production, and that collective ownership of them by the community which is commonly known as Socialism; nor between the respective advantages of gold, silver, and paper as the medium of currency. And it need hardly be said that it does not treat of the special processes by which different kinds of goods are produced. It leaves that to writers on agriculture or manufactures. It deals only with the *general* conditions in the circumstances of the nation which affect the production, distribution, and exchange of wealth.

Thus under some conditions population will increase to such an extent that there may be little more food available for its subsistence in the country than is absolutely necessary. Some accident—a bad season for instance—may interfere with the production of food, and then there will be a famine. This was the case in Ireland in 1847, and has often been so in the East and parts of India. But under different conditions—as in the western United States between 1865 and 1880—the supply of food may increase out of all proportion to the population. Under some conditions, the more demand there is for a certain class of goods, the more expensive they will become. But in many other cases, goods actually become cheaper the more they come into use. The imposition of a particular tax may ruin a whole trade, or drive it abroad. Political economy investigates the conditions under which these things happen. It does not tell you how to bring about these conditions or keep them off, though, as in the last case supposed, it may suggest what ought to be done. But in judging what ought to be done in a particular case, a number of particular circumstances must be taken into account with which the science of political economy, dealing as it does with general principles, can have nothing to do, and cannot foresee.

Thus the Factory Acts interfere with the supply of labour, and so it would seem that more wealth would be produced if they did not exist. But the statesmen who passed them had to ask—Is it desirable that wealth should be produced at the expense of the health of some of the producers? And was the health of the producers, as a matter of fact, injured in this case?

But though parts of political economy—particularly those relating to the theory of value, currency, exchange, and banking—can easily be thus isolated and studied in the abstract, a great part of the science is too closely connected with urgent questions of daily life and politics to be completely disconnected from them. The theory of wages, of taxation, of rent, all touch current practical difficulties in our daily lives. And in books on political economy we shall find, if we look very closely, two aspects of the science—pure and applied. The theories of foreign trade and of value may be classed as Pure Political Economy, while chapters on peasant proprietors and slavery may be called Applied Political Economy. But in practice the text books do not observe this distinction.

It must be remembered that when we talk of "laws" of political economy, it must not be supposed that these laws are inevitable. A "law" in science is only a statement of what always happens if certain causes are present, and if their influence is not counteracted by others. But a society is so complex that we can never be sure that there will not be counteracting causes present in some particular case. For convenience' sake we assume that there will not be, and express our assumption by stating the law as a tendency. Thus it is a "law of political economy" that population tends to increase faster than food. Population is observed to double itself in a certain period: the supply of food, with some rare exceptions, is not doubled in the same period, and certainly cannot go on multiplying at the same rate as population. But it does not follow that population *must* always actually be increasing faster than food, for famine or war or disease may in a particular case remove the surplus population, or the population may be few and industrious, and their land very fertile. Everyone who has tried chemical experiments will know how often they fail. There is some wetness or dirt or some other unforeseen cause present which makes some particular experiment go wrong. Social phenomena are far more complex than chemical, and depend partly on the human will—which introduces an indefinite degree of uncertainty.

Much discussion has taken place as to the proper method of studying political economy. Should it be inductive or deductive? If it is inductive, we shall form our conclusions after a study of how governments and individuals have behaved in the past, of the systems of distribution and exchange that have actually existed. If it is deductive, we shall make assumptions as to what we may expect people to do under given circumstances, and then see how far the facts bear us out. In dealing with rent, for instance, should we start by examining the history of land tenure in all ages; or should we assume, what is not far from the truth in England to-day, that the landowner lets his land to a farmer who works it with his own capital and hired labourers, and that both landowner and farmer wish to make the best bargain they can for themselves?

Hitherto the latter or *deductive method* has been that usually followed. It is only quite recently that the economic history of past times has been really known: ordinary histories do not notice facts connected with the life of the people in any detail, and these have to be hunted up from old account books, lists of prices, accounts of trade customs, histories of guilds, and the like. Until early in the present century there were no census returns, and the increase of the population could only be guessed. Hardly anything, again, was generally known as to the history of land tenure until within the last forty or fifty years. Even now much of the information on some subjects—as to strikes for instance, or co-operation

—can hardly be obtained, save by personal inquiry among masters and workmen: it is only within the last twenty years or so that books dealing with the subject have been accessible. But before studying political economy by the *inductive method* we ought to know all about these subjects. Moreover, were we to use the inductive method alone, we should hardly know what to look for among the mass of facts. In investigating the Irish Land Question, for instance, we should be dazed by the multitude of details about head rents, and subletting, and the Ulster custom and so forth, unless we had some preliminary notion of the way in which the shares of the produce between landlord and tenant would be determined under much simpler conditions than actually occur. No scientific investigation was ever yet conducted without some such preliminary theory. It may prove right or wrong, as compared with the facts, but at any rate it enables the investigator to see his way into them.

The deductive method takes its assumptions—on the whole—from the state of things existing at present in modern countries, especially in England. It leaves out of sight various special circumstances which modify that state, and assumes (1) that each man is a free agent, (2) that he is trying to get as much wealth as possible. Thus it leaves out of sight (for instance) the possibility of slavery, or of legislative interference with certain kinds of production or exchange, or of voluntary refusal by a workman to work overtime, and a multitude of other special circumstances. And it assumes that the produce of land is divided between three classes only—landowner, capitalist-farmer, and labourer. Of course, landowner, capitalist-farmer, and labourer are often the same person, as in the peasant proprietorships of France and the Channel Islands; the English landlord often provides some of the capital in the form of buildings, etc.; and the land is often mortgaged. But it is convenient to leave out these cases and to ask what will happen under simpler conditions than the reality. Again, suppose new machinery is introduced into a trade, which does work hitherto done by men, these men lose their employment and find their way into other trades. Often they have great difficulty in doing so; but this, though it is of vast importance in practice, may be overlooked till we come to practice; and we may say that labour displaced by machinery *tends* to find its way elsewhere. It is a confusion between the theoretical and the practical aspect of the science that has led to its being called "hard-hearted" and "selfish." Thus when an eminent manufacturer once said that he had displaced men by machines, and had "left the men to those natural laws which govern society," he showed that he had ignored in practice circumstances which ought to be ignored only while we are working at abstract theory.

There are special reasons for the form these assumptions have taken in the history of the last century. Governments then interfered very much with trade and manufacture, with the best intentions and very bad results. Under Louis XIV. of France methods of manufacture of cloth and silk were prescribed in great detail by the Government, so that in practice no improvements could be adopted by the manufacturer. And, to improve the revenue, there were all kinds of taxes and restrictions on the carriage of goods. The study of economic policy attracted much attention in France shortly afterwards, and these bad results were clearly seen. When Louis XIV.'s minister, Colbert, asked a merchant how he could best promote trade, the latter replied, "*Laissez faire, laissez passer*" (*i.e.*, leave manufacture alone and let goods move about freely). And these words were a sort of motto of the new school. They are used in a somewhat different sense—"Let the Government leave things alone"—in current political discussion. So that some of the first modern students of economic subjects were strongly inclined to regard an ideal society as a collection of free individuals. Moreover, there were two main theories of government current at that time. (1) The State was a divine institution, and the King was a viceroy for God, bound to take all possible measures for the good of his subjects, and to interfere as much with their freedom as might be good for them, just as a parent might with very young children. This was Louis XIV.'s theory, and in practice it did not work. (2) The State was a voluntary union of individuals (naturally free) for the protection of their lives and properties, but they ought to retain as much of their liberty as they possibly could. All the great political economists of the last century, and many in the first half of this, have been more or less biassed by this second theory. Of late years economic history has been so much studied (especially in Germany) that a reaction in favour of the *inductive method* has taken place. But inductive economists are apt to lose themselves in the masses of fact they have to deal with. The current method in France and England is still deduction, corrected by reference to the actual facts.

Political economy deals with the production, exchange, and distribution of wealth, and with the special effect produced on these processes by the action of Government. But it does not (except incidentally) treat of the consumption of wealth, partly because that often involves complicated moral considerations which are best studied separately.

Wealth is any commodity which possesses an exchange value.

Political economy is at the disadvantage that the terms it uses almost all have a popular sense as well as the stricter sense in which the economist uses them. In chemistry there is no doubt as to the meaning of "hydrogen" or "methyl"; in political economy not only does "wealth" in ordinary language sometimes mean general well-being, but it sometimes includes and sometimes excludes physical advantages and even personal qualities. Thus the skill of a clever surgeon, or the strength of an athlete, might be said to be a very great part of their wealth. Economists are not agreed as to whether they will include or exclude personal qualities. We shall here exclude them, and adopt the most precise and restricted definition of wealth. We shall confine it to material commodities which are capable of being exchanged. Thus the skill of a surgeon is not wealth according to this definition, because he cannot transfer it and get rid of it as he might do with a coat or a house.

Economists have sometimes disputed whether what is *representative* of wealth is to be classed as wealth. A mortgage-bond or a bank-note or a pawn-ticket derives all its value from the fact that it represents material commodities—coin or goods. Clearly there is no more wealth in the world simply because some document is created to represent some of what there already is. We shall therefore consider these simply as representing wealth, though we may for brevity sometimes speak of them as wealth instead of what they represent. Rights of way, the goodwill of a business, a copyright, cause slightly more difficulty. But these have a value simply because they represent certain advantages for which people are ready to give a material consideration in coin or goods. We may therefore say that wealth is material commodities, having an exchange value.

Value means either the utility of a thing, *i.e.*, its capacity for satisfying desire—thus the utility of a cut flower is solely to give pleasure by its look and scent—or the quantity of other things which other people will give in exchange for that. "Utility" is sometimes called value-in-use, but it must be borne in mind that it *only* means capacity for satisfying desire. A political economist who was a teetotaller, would still class beer as wealth, because as a political economist he would only be confusing his subject if he brought the temperance question into it. If people buy drink, that is enough. "Value" originally meant exchange value, and when standing alone it always has that meaning in political economy.

Now why has a thing an "exchange value"? Primarily, of course, because it satisfies a desire; but if it can be got for nothing, of course nobody will give anything for it. There must therefore be some labour or trouble necessary to get the thing; that is, *the quantity of it available must be limited.* Concisely we may say that the two conditions of exchange value are *utility* and *limitation*, or capacity of satisfying desire and difficulty of attainment.

Now in most cases the simplest way of overcoming this latter difficulty is to *make* or *get some more of the thing;* and supposing the "utility" of the thing to remain constant, the exchange value will be proportionate to the amount of labour and material expended in making the thing—including the expenditure of raw material, fuel, the wear and tear of machinery, etc. But we may say that this material, fuel, machinery, etc., also depends for its exchange value partly on the amount of labour involved in getting it, partly on the wear and tear of the machinery used. And at every stage in the history of the material or machinery we shall find that more and more of its value seems traceable to labour. It is because the possessor has either worked for it, or given wealth which represents past work for it, that he insists, as a rule, on exchanging it, and does not give it away. The more trouble it would take to get more, the higher value, other things being equal, he will put on the thing. Hence it is sometimes said that "wealth is only crystallised labour."

But this is far from being universally true. The site of a house in Cornhill gets more valuable year by year, though no labour has meanwhile been expended on it at all. For many years the pictures of most well-known artists fetched an increased price every time they were put up for sale in England. Wine "for laying down" can be purchased at perhaps 30s. per dozen; but fifteen years hence, when it has matured, it will be worth 60s. Yet all that time it will have been simply lying still in a cellar. No labour will have been put into it save that of transporting it from the wine merchant's to the purchaser's cellar. And it would sell for no more just after it is transported there than just before. So clearly some of its value hereafter will not be due to labour.

Economists who have regarded value as "crystallised labour" have had to treat these cases as exceptional. But it is simpler and more correct to say that value is in no case due *directly* to labour, though in most cases it is due to labour *indirectly* and in part. Primarily, a thing must be wanted, and the persons who want it must have some difficulty in getting it. This difficulty may often be lessened in practice by making more of the thing, and when this can be readily done the value, as a rule, may be measured by the cost of production—the labour and capital expended on making the thing. But it generally cannot be done at once.

Economists therefore distinguish two kinds of value (and price, which is value expressed in money), market value and natural or normal value. Market value depends on the relation between the *quantity demanded* and the quantity offered, or as it is put for shortness "on demand and supply." Suppose that on a certain day the buyers in a certain market want 1,000 quarters of corn. They might, of course, "want" it, in the sense that they would be glad to have it, but not be prepared to pay for it; but this kind of demand does not count. It is only the "effective demand" of persons prepared to pay, or exchange something, for what they want which political economy takes into account. But suppose that only 800 quarters are offered for sale, and that the buyers are prepared to give yesterday's price, say 30s. a quarter, but the sellers, knowing that the supply is short, hold out for more. Now the buyers probably want the wheat in very different degrees. Some may be millers with urgent orders for flour, and no wheat to grind; others may be ready to wait a day or two, or a week or two, till more comes in. Presently an anxious buyer will offer 32s. The news will spread and the sellers hold out for 32s. But perhaps only half the buyers care to give that price, but between them they will take the 800 quarters. We shall then have 800 quarters demanded at 32s., and 800 quarters supplied at 32s., because the price by rising has cut off some of the demand. That is, in order that the exchange may be complete—that there may be no buyers who are willing to pay the market price left unsatisfied, and no sellers left with stock in hand—the "price must be so adjusted as to equalise demand and supply."

The "market price" then is the price arranged at a particular time by bargaining between buyer and seller. For the sake of simplicity pure political economy assumes (what is rarely the case) that the competition is perfect, that is, that each seller and each buyer knows what his competitors are doing: so that if one buyer offers 32s., every other buyer who does not find he cannot afford that sum, offers it as well, *i.e.*, "that there cannot be two prices at the same time in the same market."

But now, what guides the seller in selling? As a rule, he cannot sell below what his goods have cost him, nor can the producer sell to him for less than what they have cost *him*. What they have cost the producer—the labour, the wear and tear of tools and machinery, etc., expressed in money—is this "cost of production." So that in most cases the normal value depends on cost of production.

Not, however, in all. If iron cost 80s. a ton to produce one year and only 78s. the next, it is clear that the makers of iron at the former price cannot stand out for 80s. New iron would be produced at 78s. and sold for a trifle more, and no one would buy theirs at all. So they will have to sell at 78s. 6d. or so and bear the loss—that is, normal value is dependent on cost of reproduction.

In many cases there is no normal value. A picture by Raphael is worth just what anybody likes to give for it. The buyer knows how much he wants it, and if he offers £20,000 for it that is his business. The picture being unique, there can be no rival seller to bring down the price, though rival buyers may force it up.

We may for the present leave the consideration of value, noting only that the difference in the difficulty of reducing the limitation, which is one of its two essential elements, has important results. Some kinds of wealth, *e.g.*, the pictures by a dead artist, cannot possibly be increased. Most kinds—manufactured goods especially—can be increased practically to any extent, and the more demand there is for them, the more competition there is among their makers to undersell each other; so that invention is stimulated, cheaper methods of manufacture invented, and so with the increase of demand the supply may increase even faster and the price actually fall. But this is not so with agricultural produce. After a certain point increased production is attended with more than proportionately increased difficulty, because the land and its productive powers are limited. True, the raw material of manufactured goods is finite in quality, but its value is so small usually in comparison to the total value that we need not consider how a rise in the first will affect the second. But clearly we cannot go on increasing the product of land at the same rate. How many gardens or wheatfields in England could supply more than twice or thrice as much as they do now by any imaginable method of cultivation? We shall see by-and-by that this has important results in connection with rent.

APPLIED MECHANICS.—IX.

[*Continued from p. 33.*]

WORK REPRESENTED BY AN AREA—CURVES AUTOMATICALLY DRAWN—WATT'S INDICATOR—MODERN IMPROVEMENTS—THE INDICATOR DIAGRAM—INDICATED HORSE-POWER—EXAMPLES.

SINCE work is the product of two things, force and distance, it is evident that it is such a quantity as can be represented by an area. This will readily be seen in the case where the force is constant, for the area is then a rectangle. Take any height O B (Fig. 52), measured along a vertical line O P, of such a length that it shall represent the constant force to any convenient scale, and let the horizontal length O A represent the distance through which the force acts, then the product of the two, or the work done by the force, is evidently represented by the area of the rectangle O A C B. If O B represents pounds and O A feet, the area will represent foot-pounds; in fact, every rectangular unit, which has for its base a length representing one foot and for its height a distance representing one pound, will represent one unit of work. The work done by a *variable* force can also be represented by an area. In Fig. 53 let the curve E D be such that its ordinate at any point represents the amount of the force at the corresponding point of its straight path (represented by O D), then the area of the space included by the curve E D and the straight lines O E and O D represents the work done by the *variable* force in question whilst acting through a distance represented by O D.

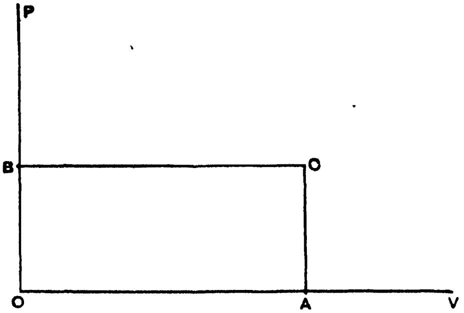

Fig. 52.

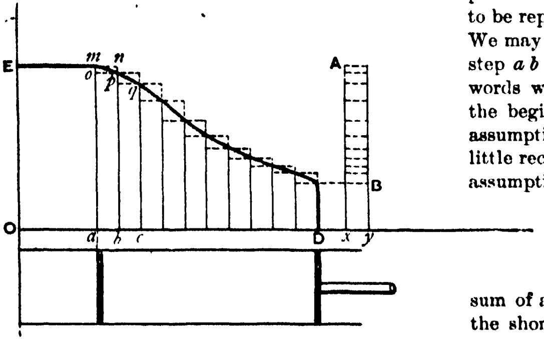

Fig. 53.

Imagine the force to be that exerted by the steam on the piston of a steam engine. Suppose the piston, instead of moving as it usually does, to move forward by little steps, the pressure on it, let us suppose, remaining constant during each step, then suddenly changing to a different value and remaining constant for the next step, and so on. The piston and cylinder are shown in the lower part of the figure, and we may imagine each step to be represented by the equal distances *a b*, *b c*, etc. We may either assume that the pressure during the step *a b* is represented by *a o* or by *a m*; in other words we may suppose the pressure to change at the beginning or end of the step. If the former assumption be made throughout, the sum of all the little rectangles will be too small; and if the latter assumption be made, the sum of all the rectangles is a little too great, to agree with the real area included by the curve E D. Projecting the little areas *m p*, *p q*, etc., across, we see that the difference between the sum of all the longer rectangles and the sum of all the shorter ones is equal to the area A B, the base of which *x y* is equal to *a b*. The real area then differs from the sum of either set of rectangles by a quantity less than the area of A B, which can be made as small as we please by diminishing each of the distances *a b*, *b c*, etc., sufficiently, or, what is the same, by dividing O D into a sufficiently great number of equal parts. In the limit, then, if we could take an *exceedingly* large number of parts we should find A B vanish, or, in other words, the work done by the piston, which is certainly represented by the sum of the rectangles in the case of the jerky motion assumed, is also represented by the area enclosed by E D when the motion and pressure

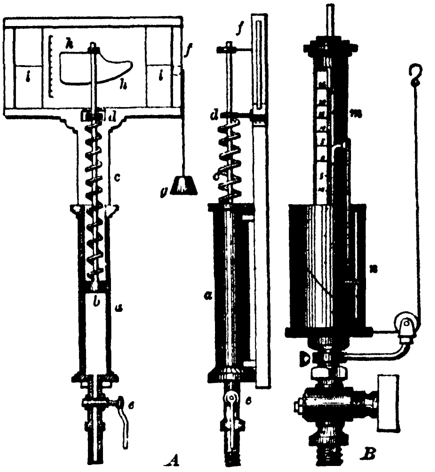

Fig. 54.

are such as we have in actual practice. If the piston in this case is one square inch in area, the curve E D will show the variation of the steam pressure *per square inch*, and the curves we have to deal with in actual practice do usually show, not *total* pressure, but pressure *per square inch*, or pressure *per unit area.*

Such a curve as we have here described is drawn automatically by a most ingenious and useful apparatus, which owes its existence to the inventive genius of the famous James Watt.

THE STEAM-ENGINE INDICATOR.

This instrument, as invented by Watt, had many defects, but it has now been improved so much as to give results of very considerable accuracy, and of very great importance. Watt's instrument consisted of a cylinder *a* (Fig. 54, part A), in which a piston *b* worked loosely, being pressed downwards by a rather weak spiral spring. The piston-rod worked through a collar D, and had at its upper end a device for holding a pencil. The cylinder *a* was attached to the cylinder of the steam engine, and communication could be made between the two by turning the tap *e*. When the tap was opened, the steam pressed the piston *a* up, compressing the spring until *its* push equalled the total pressure of the steam on the little piston *b*, which was usually made one square inch in area. In order that the pencil might draw the curve of pressure, a small movable frame with a sheet of paper on it was moved backwards and forwards in front of the pencil with a motion the miniature of that of the piston of the engine. Thus the pencil moved upwards and downwards in accordance with the steam pressure, and the paper moved under the pencil in the same way as the main piston of the engine. These two motions taking place at the same time, the curve *h h* was drawn on the paper. This curve not only showed how the pressure varied in the cylinder of the engine during the cycle of operations, but it also gave by its area a means of determining the amount of work done by the steam on the piston of the engine during that period.

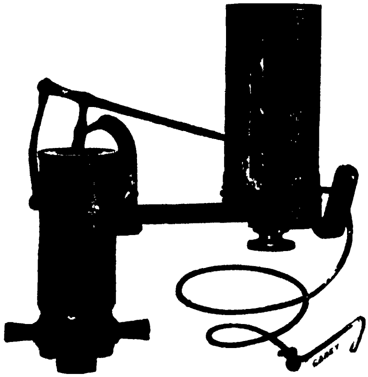

Fig. 55.

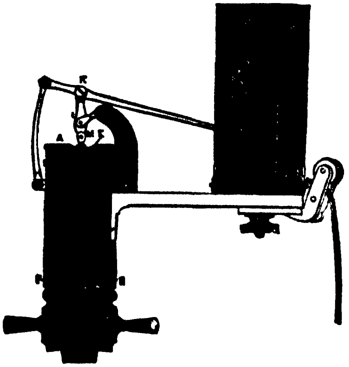

Fig. 56.

Part B of the same figure shows a modification introduced by McNaught, in which the paper frame or drum is cylindrical and surrounds the indicator cylinder, having a circular, instead of a straight-line, reciprocating motion, being pulled one way by a string attached to some part of the engine and brought back by a spring resembling the main-spring of a watch.

The main defect of Watt's indicator was its weak spring, which was necessitated by the fact that the pencil was attached *directly* to the indicator piston; and hence if the pencil's indications were sufficiently large, the piston had to move, or the spring yield, a good deal. This defect has been remedied in modern indicators by having the pencil attached, not directly to the indicator piston, but in such a way that it moves *like* the piston, though much farther. This will be understood from an examination of a good indicator, or the drawing of one, such as Figs. 55 and 56, which are an elevation and section of the Crosby Indicator, made by the Crosby Steam Gauge and Valve Company, of Boston, U.S.A.

The student will find it both interesting and instructive to study the details of this excellent indicator, which we have shown in order that it may be compared with Watt's. For high speeds and pressures, such as are used at the present day, Watt's indicator would be of no use. In this indicator, which we have not time to describe fully, but which will readily be understood from the

figures, the spring (shown in Fig. 57) is double and very stiff, one end being screwed into wings at D (Fig. 56), whilst the other end has a steel ball fitting a socket in the hollow piston-rod at G, so allowing free motion and preventing sticking of the piston. Different springs are used depending on the pressures dealt with, the object being to have the diagram always of a convenient size.

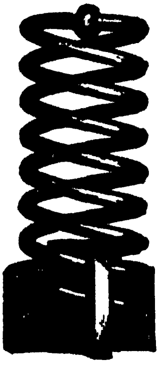

Fig. 57.

The way in which the magnified motion of the pencil is obtained will be seen from the figure, as well as the arrangement of the paper drum, which is controlled by a *spiral* spring.

The student will probably wonder how a weak spring produces its bad effect. Let him try an experiment by hanging up a weak spring and a strong one with a weight at the end of each. Now set them vibrating up and down, and it will be seen that the weak spring vibrates slowly but with swings of large amplitude, whereas the strong spring vibrates quickly and with short vibrations. If the weak spring gets a sudden motion, as it does in the indicator when the steam enters it, it vibrates slowly, making perhaps two or three vibrations whilst the pencil traces out its curve, and hence producing a figure which is useless; whereas the strong spring makes a large number of small vibrations which only produce ripples on the real curve, and do very little harm. We may refer to this more fully when we come to the lesson on spiral and other springs.

What we are more concerned with in this lesson is how to translate the record of work given by such an instrument, or, in other words, *how to find the indicated horse-power from the diagram.*

THE INDICATOR DIAGRAM.

The indicator diagram shown in Fig. 58 was taken from a steam engine, by such an instrument as we have described. This diagram was taken from one end of the cylinder of the engine, and therefore shows the work done on one side of the piston whilst it was traced out, that is, in a forward and backward stroke, or in one revolution of the crank-shaft, a similar diagram being obtained from the other side of the piston.

One way of proceeding to interpret the diagram would be to find its area, and knowing the vertical and horizontal scales used for pressure and travel, the work represented could be obtained.

It is usual to find the ***mean effective pressure of the steam*** from the diagram, and then knowing the area of the piston and its average travel per minute, the work done per minute and the power are easily calculated. There are several methods of finding the mean pressure from the diagram; we will only describe two.

Divide the length of the diagram $o\,o'$ into, say, ten equal parts, and erect an ordinate at the centre of each part as in the figure. Measure the total length of these ordinates; this you can easily do by marking off the ordinates consecutively on a strip of paper and then measuring the whole length indicated on the strip. Divide this length by the number of ordinates—in this case ten—the quotient gives the mean height of the diagram. Multiply this mean height by the number of pounds per square inch which one inch vertically on the diagram represents; the product is the mean pressure required. Thus the sum of the ordinates of the diagram represented in Fig. 58 was $9\frac{7}{16}$ inches, which divided by 10 gives the mean height of the diagram. The spring of the indicator was such that the pencil moved vertically on the paper one inch for a rise or fall of pressure amounting to 32 lb. per square inch, hence the mean pressure required is

$$9\tfrac{7}{16} \div 10 \times 32 = 30\ 2 \text{ lb. per square inch.}$$

Let us now find the indicated horse-power of the engine, the diameter of the piston being 12 inches, length of crank 12 inches, speed 96 revolutions per minute.

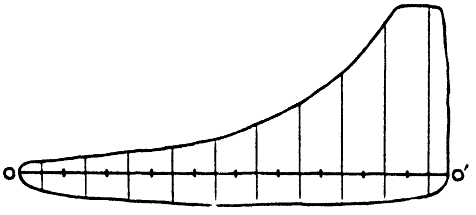

Fig 58.

The total average pressure on the piston (neglecting the fact that the area of the piston exposed to steam pressure is not the same on both sides) is

$$30{\cdot}2 \times {\cdot}7854 \times 12^2 = 3415{\cdot}5 \text{ lb.}^*$$

The piston travels 2 × 12 or 24 inches each stroke, or 4 feet for every revolution of the crank, and there are 96 revolutions per minute, hence the piston goes 96 × 4 = 384 feet per minute.

The work done per minute is therefore

$$3415{\cdot}5 \times 384 \text{ foot-pounds,}$$

---

* The student probably knows that the area of a circle is ·7854 times the square of its diameter.

and the power required is

$$\frac{3415·5 \times 384}{33000} = 39·74 \text{ horse-power.}$$

The student should carefully note the fact that it is only the distance the piston goes per minute *under pressure from the steam or other working fluid* that is taken as distance passed through in computing the work done. In a single-acting engine, for instance, the distance would be half that actually moved by the piston.

The other method of finding mean pressure to which we referred consists in finding the area of the diagram—say, in square inches—by means of a planimeter, or other method of measuring areas. Then since

$$\text{mean height} \times \text{length} = \text{area},$$

the mean height in inches is found by dividing the area in square inches by the length $v\,o'$ in inches. The mean pressure can thus be obtained as already explained.

NUMERICAL EXAMPLES.

The student is now in a position to work out a few examples.

1. The mean pressure of the steam in the cylinder of a certain steam-engine is 26 lb. per square inch, the diameter of the cylinder of the engine 12 inches, length of crank 12 inches, and the speed 96 revolutions per minute; find the indicated horse-power of the engine. Answer, 34·2.

2. The mean height of an indicator diagram is $1\frac{1}{2}$ inches, the scale of the diagram being such that an ordinate one inch long represents a pressure of 30 lb. per square inch; if the dimensions and speed of the engine are the same as in the last example, find the indicated horse-power. Answer, 59·22.

3. An indicator diagram has an area of 4 square inches, the vertical scale of the diagram being the same as in the last example, and its horizontal length 3 inches; if the piston of the engine from which the diagram was taken is 9 inches in diameter, the stroke of the piston 28 inches, and the speed 120 revolutions per minute, find the indicated power of the engine. Answer, 43·18 horse-power.

4. An Otto gas engine has a piston 12 inches in diameter, an 8-inch crank, speed 150 revolutions per minute; the exploding gas doing work on the piston only during one stroke out of every four. If the mean pressure, as found from the indicator diagram, is 62·2 lb. per square inch, find the indicated power of the engine. Answer, 21·32 horse-power.

5. A water-pressure engine with three cylinders is worked by water from an accumulator at a pressure of 700 lb. per square inch; if the diameter of each piston is 5 inches, stroke 1 foot, and speed 55 revolutions per minute, find the "indicated" horse-power of the engine, it being single-acting, and the water acting at full pressure on the piston throughout the whole stroke. Answer, 22·9 × 3.

ITALIAN.—VIII.

[*Continued from p.* 29.]

ADJECTIVES.

ITALIAN adjectives either terminate in *o* or in *e*; as, *pô-ve-ro*, poor; *fôr-te*, strong.

The adjectives terminating in *o* are of the masculine gender, and become feminine by changing *o* into *a*. The masculine adjectives of this class, in the plural, change *o* into *i*; and the feminine, *a* into *e*; as :—

SINGULAR.	PLURAL.
Il pô-ve-ro uô-mo, the poor man	*I pô-ve-ri uô-mi-ni*, the poor men
La pô-ve-ra dôn-na, the poor woman.	*Le pô-ve-re dôn-ne*, the poor women.

The adjectives terminating in *e* are used for the masculine as well as for the feminine gender. They change *e* into *i* in the plural; as :—

SINGULAR.	PLURAL.
Il cap-pél-lo vér-de, the green hat.	*I cap-pél-li vér-di*, the green hats.
La fô-glia vér-de, the green leaf.	*Le fô-glie vér-di*, the green leaves.

Italian adjectives must agree with the nouns to which they belong or refer in gender and number; as :—

Un uô-mo dôt-to e ra-gio-né-vo-le, a learned and sensible man.
Uô-mi-ni dôt-ti e ra-gio-né-voli, learned and sensible men.
Ù-na dôn-na sa-via e pru-dén-te, a wise and prudent woman.
Quel-le don-ne só-no sa-vie e pru-dén-ti, those women are wise and prudent.

Mêz-zo, when it means *la me-tà*, the half or moiety, in the singular, either agrees with the noun or remains unaltered. It must remain unaltered in the plural; as :—

Un ó-ra e méz-za, or *un ó-ra e méz-zo*, one hour and a half.
Ù-na lib-bra e méz-za, or *u-na lib-bra e méz-zo*, one pound and a half
Du-e lib-bre e méz-zo, two pounds and a half.
È-ra méz-zo môr-ta per lo spa-vén-to, she was half dead with fright.

Of adjectives connected with and following each other, only the *last* agrees with the noun in gender and number; as :—

Os-ser-va-zió-ni stô-ri-co—crì-ti-che, historical and critical remarks.
Stú-dii po-lì-ti-co—le-gá-li, political and legal studies.

An adjective which refers to *two* or more nouns of *different* genders takes the *plural* number and *masculine* gender; as :—

L'uô-mo e la dôn-na só-no sog-gét-ti âl-le stés-se pas-sió-ni, man and woman are liable to the same passions.
Gli âl-be-ri e le vi-ti fu-ron di-strút-ti dál-la gra-gnuô-la, the trees and the vines were destroyed by the hail.

The adjectives *bél-lo*, beautiful; *grán-de*, great, large; *sán-to*, holy; and the masculine pronoun *quél-lo*, that, sometimes drop the last syllable. With regard to this abbreviation, the following rules must be adhered to:—

1. The above-mentioned words can only drop their last syllable when they *precede* a noun.

2. The initial letter of this noun must be a consonant which is not the *s* impure.

3. They take the apostrophe before nouns commencing with a vowel.

4. They must *never* be abbreviated before nouns beginning with the *s* impure.

5. *Bél-lo* and *quél-lo* only drop the last syllable in the singular and before nouns of the *masculine* gender.

6. *Grán-de* also drops the last syllable in the singular and before nouns of the masculine gender; but, in addition to this, it may lose its last syllable before a noun of the *feminine* gender, and also in the plural before nouns of *both* genders.

7. *Sán-to* only drops the last syllable before a *proper name* of the masculine gender and singular number. It must also *immediately* precede the proper name.

Buó-no only drops its final vowel when immediately preceding a noun commencing with a consonant which is not the *s* impure; as:—

Buón fi-glio, good son.
Un buó-no ed o-né-sto vec-chio, a good and honest old man.

In most cases, *emphasis* or *euphony* will be the best guide for deciding whether an adjective is to be placed *before* or *after* a noun; as:—

Con ver-gó-gna e-tér-na, or *con e-tér-na ver-gó-gna*, with eternal dishonour.
Un ca-vál-lo bel-lís-si-mo, or *un bel-lís-si-mo ca-vál-lo*, a very beautiful horse.

Some adjectives have a different meaning, according to their position before or after a noun. As an illustration of this, a few of the most important phrases of this kind will be sufficient:—

Un ga-lánt'uó-mo, an honest man.
Un uó-mo ga-lán-te, a genteel, polite man.
É-gli a-vé-va pró-prio ve-stí-to, he had his own dress.
Un ve-stí-to pró-prio, a neat, clean dress.
Un gen-til uó-mo, a gentleman by birth, a nobleman.
Un uó-mo gen-tí-le, a well-bred, genteel, courteous man.
Il pó-ver uó-mo! quán-to dé-ve sof-frí-re, poor, unfortunate man! how much must he suffer.
L'uó-mo pó-ve-ro, the poor man (opposed to rich).

Adjectives frequently require a particular case or particular prepositions after them; as—

Am-ma-lá-to, in-fér-mo di cór-po e di á-ni-ma, sick in body and in mind.
Con-tén-to del-la sú-a sór-te, satisfied with his lot.
É-gli mi è in-fe-rió-re di rán-go, he is my inferior in rank.

VOCABULARY.

Advantage, *van-tág-gio.*
Ambrose, *Am-bró-gio.*
Are, *só-no.*
Are as, *só-no co-sì.*
Arm, *brác-cio*, (pl. *le brác-cia*, f.).
As, *có-me.*
Austrian, *au-strí-a-co.*
Blue, *tur-chí-no.*
Body, *cór-po.*
Book, *lí-bro.*
Business, *af-fá-re*, m.
Carthage, *Car-tá-gi-ne.*
Commerce, *com-mér-cio.*
Contains, *con-tié-ne.*
Continually, *con-ti-nua-mén-te.*
Coral, *co-rál-lo.*
Courage, *co-rág-gio.*
Day, *gior-ná-ta*, f.
Dear, *cá-ro.*
Demosthenes, *De-mó-ste-ne.*
Diamond, *dia-mán-te*, m.
Died, *mo-rì.*
Emerald, *sme-rál-do.*
English, *in-glé-se.*
Epistle, *e-pí-sto-la.*
Flower, *fió-re*, m.
For, *per.*
French, *fran-cé-se.*
Fruit-tree, *ál-be-ro frút-ti-fe-ro.*
Garden, *giar-dí-no.*
George, *Giór-gio.*
Godfrey, *Gof-fré-do.*
Great, *grán-de.*
Greek, *gré-co.*
Green, *vér-de.*
Grow, *cré-sco-no.*
Had, *a-vé-va-no.*
Happy, *fe-lí-ce.*
Has given me, *mi ha do-ná-to.*
He had, *é-gli éb-be.*
Horse, *ca-vál-lo.*
Hungarian, *un-ghe-ré-se.*
Hyacinth, *gia-cín-to.*
In the sea, *in má-re*, m.
In which, *nel quá-le* (or *in cui*).
Interpretation, *spie-ga-zió-ne*, f.
Lad, *gió-va-ne*, m.
Large, *grós-so.*
Last year, *l'án-no scór-so.*
Life, *ví-ta* (with the genitive).
Little tree, *ar-bo-scél-lo.*
Milan, *Mi-lá-no.*
Now, *a-dés-so.*
One must have, *bi-só-gna a-ve-re.*
Orator, *o-ra-tó-re*, m.
Out of, *fuó-ri di.*
Passage, *pas-so.*
Paul, *Páo-lo.*
Pearl, *pér-la.*
Peter, *Pié-tro.*
Precaution, *cir-co-spe-zió-ne*, f.
Precious stone, *gém-ma*, f.
Prince, *prín-ci-pe*, m.
Red, *rós-so.*
Rome, *Ró-ma.*
Ruby, *ru-bí-no.*
Sapphire, *zaf-fí-ro.*
Shape, *fór-ma.*
Shell, *con-chí-glia.*
Small, *pic-co-lo.*
Spanish, *spa-gnuó-lo.*
Stephen, *Sté-fa-no.*
Stock, *prov-vi-gió-ne*, f.
Subject, *súd-di-to.*
Such, *tá-le.*
Talent, *di-spo-si-zió-ne*, f.
Theodosius, *Teo-dó-sio.*
There are, *vi só-no.*
There were, *tro-vá-van-si.*
Thought, *pen-sié-ro.*
To learn everything with ease, *d'im-pa-rár tút-to fa-cil-mén-te.*
Town *cit-tà.*
Transparent, *diá-fa-no* (or *tras-pa-rén-te*).
Travelling, *viag-giá-re.*
Treats, *trát-ta.*
Uncle, *zí-o.*
War, *guér-ra.*
Was, *é-ra.*
We have, *ab-biá-mo.*
Weather, *tém-po.*
White, *bián-co.*
Who are loved, *i quá-li vén-go-no a-má-ti.*
Wine, *ví-no.*
With one another *tra di ló-ro.*
Writing, *scrít-to.*
Yellow, *giál-lo.*
You have, *voi a-vé-te.*

EXERCISE 25.

Translate into Italian:—

1. I love my brothers and sisters. 2. I love also my cousins (*m.*) and my cousins (*f.*). 3. I have received two apples and four pears from this gardener. 4. My cherries are very beautiful. 5. Hast thou watered thy flowers? 6. Thy brothers have bought two dogs, which are very faithful. 7. My sisters have received two cats from our uncle; they are very pleased. 8. Our sisters have departed this week, and our mother is very sad 9. Thy brothers have received two lead pencils from my cousin; they are my cousin's friends. 10. I have bought at Milan four looking-glasses for my cousins (*f.*). 11. My aunt has sent her daughter to Rome.

AUXILIARY VERBS.

The conjugation of Italian verbs, compared with that of the English, offers the following peculiarities:—

The personal pronouns *í-o*, I; *tu*, thou; *é-gli*, *és-so*, he; *él-la*, *és-sa*, she; *nói*, we; *vói*, you; and *é-gli-no*, *és-si* (m.), *él-le-no*, *és-se* (f.), they, may be omitted before the Italian verbs; because their persons, with an unmistakable clearness, are expressed by the difference of their terminations: as, *á-mo, á-mi, á-ma, a-miá-mo, a-má-te, á-ma-no,* I love, thou lovest, he (she) loves, we love, you love, they love, is equivalent to *í-o á-mo, tu á-mi, é-gli (él-la) á-ma, nói a-miá-mo, vói a-má-te, é-gli-no (él-le-no) á-ma-no.* In two cases, however, even before Italian verbs, the personal pronouns are indispensable. In the first place, when they are required by emphasis or contrast; thus, *í-o v'en-tre-rò dén-tro,* I shall enter; *nói er-riá-mo, nói siá-mo in-gan-ná-ti, e non vói,* we are mistaken, we are cheated, not you. In the second place, in the singular, before the three persons of the subjunctive of the present, and also in the singular before the first and second person of the subjunctive of the imperfect, which are alike, the personal pronouns, for the most part, ought to be used to avoid confusion; thus, *che í-o áb-bia, che tu áb-bia, ch'é-gli áb-bia,* that I may have, that thou mayest have, that he may have, etc.

The Italian conjugation has *four* tenses formed without the aid of auxiliaries, the present, the imperfect, the indeterminate preterite (*pas-sá-to in-de-ter-mi-ná-to*), and the future.

The Italian language has several regular forms for the conjugation of its verbs.

CONJUGATION OF THE AUXILIARY VERB *ÉS-SE-RE,* *to be.*

I. INDEFINITE MOOD.

Present.—Ès-se-re,[1] *to be.*
Preterite.—Ès-se-re stá-to, *to have been.*
Future—Ès-se-re per ès-se-re, *or* a-ve-re ad ès-se re, *to be about to be.*
Present Participle.—Es-sên-te, *being, existing* (obsolete).
Preterite Participle.—Stá-to (sing.), stá-ti (plur.), *been.*
Present Gerund.[2]—Es-sên-do, *being.*
Preterite Gerund.—Es-sên-do stá-to, *having been.*
Future Gerund.—Es-sên-do per ès-se-re, *or* a-vên-do ad ès-se-re, *being about to be.*

II. INDICATIVE MOOD.

Present Tense.
Sing. Í-o só-no, *I am.*
Tu sê-i *or* sè'.
É-gli (és-so) è.
[Si è, *one is.*][1]
Plur. Nói siá-mo.
Vói siê-te.
É-gli-no (és-si) só-no.

Determinate Preterite.[4]
Sing. Í-o só-no stá-to, *I have been.*
Tu sê-i stá-to.
É-gli è stá-to.
Plur. Nói siá-mo stá-ti.
Vói siê-te stá-ti.
É-gli-no (és-si) só-no stá-ti.

Imperfect or Simple Preterite.[2]
Sing. Í-o ê-ra, *I was.*
Tu ê-ri.
É-gli ê-ra.
[Si é-ra, *one was.*]
Plur. Nói e-ra-vá-mo.
Vói e-ra-vá-te.
É-gli-no ê-ra-no.

Indeterminate Pluperfect.[5]
Sing. Í-o ê-ra stá-to, *I had been.*
Tu ê-ri stá-to.
É-gli ê-ra stá-to.
Plur. Nói e-ra-vá-mo stá-ti.
Vói e-ra-vá-te stá-ti.
É-gli-no (és-si) ê-ra-no stá-ti.

Indeterminate Preterite.[3]
Sing. Í-o fúi, *I was.*
Tu fó-sti.
É-gli fu.
Plur. Nói fúm-mo.
Vói fó-ste.
É-gli-no fú-ro-no.

Determinate Pluperfect.[6]
Sing. Í-o fúi stá-to, *I had been.*
Tu fó-sti stá-to.
É-gli fu stá-to.
Plur. Nói fúm-mo stá-ti.
Vói fó-ste stá-ti.
É-gli-no fú-ro-no stá-ti.

Future.
Sing. Í-o sa-rò,[7] *I shall be.*
Tu sa-rá-i.
É-gli sa-rà.[8]
Plur. Nói sa-ré-mo.[9]
Vói sa-ré-te.[10]
É-gli-no sa-rán-no.[11]

Conditional Present.[12]
Sing. Í-o sa-ré-i[13] *or* sa-rí-a, *I should be.*
Tu sa-ré-sti.[14]
É-gli (él-la) sa-réb-be, *or* sa-rí-a.
Plur. Nói sa-rém-mo.
Vói sa-ré-ste.
É-gli-no sa-réb-be-ro, *or* sa-réb-bo-no, *or* sa-rí-a-no.

Future Past.
Sing. Í-o sa-rò sta-to, *I shall have been.*
Tu sa-rá-i stá-to.
É-gli sa-rà stá-to.
Plur. Nói sa-ré-mo stá-ti.
Vói sa-ré-te stá-ti.
É-gli-no sa-rán-no stá-ti.

Conditional Past.
Sing. Í-o sa-ré-i stá-to, *I should have been.*
Tu sa-ré-sti stá-to.
É-gli sa-réb-be stá-to.
Plur. Nói sa-rém-mo stá-ti.
Vói sa-ré-ste stá-ti.
É-gli-no sa-réb-be-ro stá-ti.

III. IMPERATIVE MOOD.[1]

Sing. Sí-i *or* sí-a tu, *be thou.*
Non ès-se-re,[2] *do not (thou) be.*
Sí-a é-gli, *let him be.*
Plur. Siá-mo nói, let us be.
Siá-te vói, *be ye.*
Sí-a-no *or* siê-no é-gli-no, *let them be.*

IV. SUBJUNCTIVE MOOD.

Present.
Sing. Í-o sí-a, *I may be.*
Tu sí-i *or* sí-a.
É-gli sí-a.
Plur. Nói siá-mo.
Vói siá-te.
É-gli-no sí-a-no *or* siê-no.

Past.
Sing. Í-o sí-a stá-to, *I may have been.*
Tu sí-i, *or* sí-a stá-to.
É-gli sí-a stá-to.
Plur. Nói siá-mo stá-ti.
Vói siá-te stá-ti.
É-gli-no sí-a-no stá-ti.

Imperfect.
Sing. Í-o fós-si, *I might be.*
Tu fós-si.
É-gli fós-se.
Plur. Nói fós-si-mo.
Vói fó-ste.
É-gli-no fós-se-ro.

Pluperfect.
Sing. Í-o fós-si stá-to, *I might have been.*
Tu fós-si stá-to.
É-gli fós-se stá-to.
Plur. Nói fós-si-mo stá-ti.
Vói fó-ste stá-ti.
É-gli-no fós-se-ro stá-ti.

I.—REMARKS ON THE INDEFINITE MOOD.

1. This is the most irregular of the Italian verbs, and, like the Latin verb *esse*, from which it is derived, it appears originally to have been formed from the fragments of several other verbs, for *só-no, é-ra, fui,* are words taken from quite different roots. It has, moreover, many other forms used in poetry or in popular dialects.

2. The Present Gerund, a peculiar form of the Italian verb, taken from the Latin, is wanting in the English, and must be periphrased by means of the particles *while, whilst, since, when, after, as, because,* etc. Sometimes, not always, its use coincides with that of the English participle.

II.—REMARKS ON THE INDICATIVE MOOD.

1. The pronoun "one" is not of frequent use in English, while *si* is of the most extensive application, and has, strictly speaking, according to the sense of the phrase, the following meanings: *people, they, we, you, a person* or *man, one.* We have inserted an example of its use in the present and imperfect tenses to enable the reader to apply it to other tenses at pleasure.

2. The imperfect tense is commonly called *pas-sá-to im-per-fêt-to,* or *pas-sá-to pen-dên-te.* The following sentence will show its use:—*Mí-o fra-têl-lo*

giún-se nél-lo stés-so têm-po che í-o gli scri-vé-va, my brother came at the same time when I was writing to him. The word *scriveva* (was writing) is the *imperfect*, while *giunse* (came) is a different form of the preterite, which we shall call the *indeterminate preterite.*

3. The indeterminate preterite tense is called *indeterminate* preterite, because the time elapsed may be a day, a year, a century, or any period of time, provided what was done yesterday or centuries ago is out of all connection with the present. It is, alternately with the imperfect, the tense most frequent in narrations.

4. The determinate preterite mostly coincides with the English perfect, expressing a past as connected with the present time, which may be an hour, a year, a century, or any period of the longest or shortest duration.

5. The indeterminate pluperfect is generally used to denote a past anterior to a determinate preterite (*tempo passato prossimo*); as, *í-o a-vé-va fi-ní-to il la-vó-ro quán-do è ve-nú-to Lú-ca*, I had finished the work when Luke came.

6. The determinate pluperfect is used to denote a past anterior to an indeterminate preterite (*tempo passato remoto*) that expresses some act or event closely following it. It is for the most part preceded by the conjunctions *poi-chè*, when, since; *do-po-chè*, after; *su-bi-to chè*, as soon as; *ap-pé-na*, scarcely, just, no sooner; *quán-do*, when, etc.: as, *sú-bi-to che êb-bi scrít-to la lêt-te-ra, par-tí-i*, as soon as I had written the letter I departed. This tense is wanting in English, as well as the indeterminate preterite (*tempo passato remoto*).

7. In the singular the first person of the future of *all* Italian verbs has the *open* sound of *o;* thus, *ó:* as, *a-me-rò*, I shall love; *te-me-rò*, I shall fear; *dor-mi-rò*, I shall sleep, etc. This person, moreover, has the grave accent on *o* in *all* Italian verbs. Old poets appear to have been no friends of accented terminations, and often said *sa-ró-e* for *sarò*, and *sa-rá-e* for *sarà.*

8. The third person singular also of the future in *all* Italian verbs must have the grave accent above the *a.*

9. In *all* Italian verbs the termination *-emo*, whenever it is the first person plural, must be pronounced with a close *e;* thus, *-é-mo:* as, *par-le-ré-mo*, we shall speak; *fa-ré-mo*, we shall do, etc.

10. In *all* Italian verbs any persons terminating in *-ete* must be pronounced with a close *e;* as, *fa-ré-te*, you will do, etc.

11. *Fí-e-no*, also *fí-a-no*, for *sa-rán-no;* and *fí-a*, also *fí-e*, for *sa-rà*, are, for the most part, used in poetry.

12. The condition itself can only be expressed by the subjunctive of the imperfect (*tempo passato di presente*), or of the pluperfect (*tempo trapassato*), generally preceded by *se* (if). These two subjunctives in their use must strictly correspond with the two conditionals, *i.e.*, the subjunctive of the imperfect goes with the conditional present, and the subjunctive of the pluperfect with the conditional past; as, *se í-o stés-so non v'an-dás-si, non ot-te-rêi má-i niên-te*, if I did not go there myself, I should not obtain anything; *se í-o stés-so non vi fós-si an-dá-to, non a-vrê-i má-i ot-te-nú-to niên-te*, if I had not gone there myself, I should not have obtained anything.

13. The termination *-rei* of all verbs has an open *e*, thus, *-rê-i;* as, *a-me-rê-i*, I should love; *cre-de-rê-i*, I should believe; *sen-ti-rê-i*, I should feel, etc.

14. The terminations *-rés-ti*, *-rém-mo*, *-rés-te* of this tense are, in point of pronunciation, alike in *all* verbs. *Sa-ri-a-mo*, for *sa-rém-mo*, is poetical.

III.—REMARKS ON THE IMPERATIVE MOOD.

1. A milder form of the imperative mood is the future tense, which particularly is in use when what is ordered is not immediately to be done, but after some other act; as, *por-tá-te qués-ta lêt-te-ra ál-la pô-sta, pô-i an-de-ré-te ál-la spe-zie-rí-a, e pren-de-ré-te dú-e ón-ce di Chí-na*, carry this letter to the post, then you will go to the apothecary's shop, and take two ounces of Peruvian bark.

2. The infinitive with the particle *non* before it is the negative form only of the second person singular in the imperative mood; as, *non an-dár ví-a*, do not (thou) go away! *non far qué-sto*, do not (thou) do that!

EXERCISE 26.

Translate into Italian :—

1. We are now having fine days continually. 2. Last year he had a large garden out of town, in which there were beautiful flowers and beautiful fruit-trees. 3. That book treats of the life of St. Stephen and of St. George, and in this there are interpretations of some passages from the epistles of St. Paul and St. Peter. 4. Theodosius the Great died at Milan, in the arms of St. Ambrose. 5. That writing contains some beautiful thoughts on the advantages of commerce. 6. In this business, one must have great precaution and great courage. 7. Demosthenes was a great Greek orator. 8. He is a good boy, and shows great talent for learning everything with ease. 9. Pearls, large or small, grow in shells; and coral grows in the sea, in the form of small trees. 10. Godfrey has a large stock of Hungarian and Austrian wines.

CONJUGATION OF THE AUXILIARY VERB *A-VÉ-RE*, *to have.*

I. INDEFINITE MOOD.

Present.—A-vé-re, *to have.*
Preterite.—A-vé-re a-vú-to, *to have had.*
Future.—A-vé-re ad a-ve-re, ês-se-re per a-vé-re, *to be about to have.*
Present Participle.—A-vên-te, *having.*
Preterite Participle.—A-vú-to, *had.*
Present Gerund.—A-vên-do, *having.*
Preterite Gerund.—A-vên-do a-vu-to, *having had.*
Future Gerund.—A-vên-do ad a-ve-re, *or* es-sên-do per a-vé-re, *being about to have.*

II. INDICATIVE MOOD.

Present.
Sing. Hò,[1] *I have.*
Há-i.
Ha.
Plur. Ab-biá-mo.
A-vé-te.
Hán-no.

Determinate Pluperfect.
Sing. Êb-bi a-vú-to, *I had had.*
A-ve-sti a-vu-to.
Êb-be a-vu-to.
Plur. A-vém-mo a-vú-to.
A-vé-ste a-vú-to.
Èb-be-ro a-vú-to.

Imperfect.
Sing. A-vé-va, a-ve-vo, *or* a-vé-a,[2] *I had.*
A-ve-vi.
A-ve-va *or* a-vé-a.
Plur. A-ve-va-mo.
A-ve-vá-te.
A-vé-va-no *or* a-vé-a-no.

Future.
Sing. A-vrò, *I shall have.*
A-vra-i.
A-vra.
Plur. A-vre-mo.
A-vre-te.
A-vran-no.

Indeterminate Preterite.
Sing. Êb-bi, *I had.*
A-vé-sti.
Êb-be.
Plur. A-vem-mo.
A-ve-ste.
Êb-be-ro.

Future Past.
Sing. A-vrò a-vú-to, *I shall have had.*
A-vrá-i a-vu-to.
A-vrà a-vu-to.
Plur. A-vre-mo a-vu-to.
A-vre-te a-vú-to.
A-vran-no a-vu-to.

Determinate Preterite.
Sing. Hô a-vú-to, *I have had.*
Há-i a-vú-to.
Ha a-vú-to.
Plur. Ab-biá-mo a-vu-to.
A-vé-te a-vú-to.
Hán-no a-vu-to.

Conditional Present.
Sing. A-vrê-i or a-vri-a, *I should have.*
A-vré-sti.
A-vrêb-be *or* a-vrí-a.
A-vrem-mo.
A-vré-ste.
A-vrêb-be-ro, a-vrêb-bo-no, *or* a-vri-a-no.

Indeterminate Pluperfect.
Sing. A-vé-va a-vú-to, *I had had.*
A-ve-vi a-vú-to.
A-vé-va avuto.
Plur. A-ve-va-mo a-vú-to.
A-ve-vá-te a-vú-to.
A-ve-va-no a-vu-to.

Conditional Past.
Sing. A-vrê-i a-vu-to, *I should have had.*
A-vre-sti a-vú-to.
A-vrêb-be a-vu-to.
Plur. A-vrém-mo a-vú-to.
A-vre-ste a-vú-to.
A-vrêb-be-ro a-vu-to.

III. IMPERATIVE MOOD.

Sing. Áb-bi or áb-bia, *have thou.*
Non a-vé-re, *do not thou have.*
Áb-bia, *let him (or her) have.*
Plur. Ab-bia-mo, *let us have.*
Ab-bia-te, *have you.*
Áb-bia-no, *let them have.*

IV. SUBJUNCTIVE MOOD

Present.
Sing. Áb-bia, *I may have.*
Áb-bi *or* áb-bia.
Áb-bia.
Plur. Ab-biá-mo.
Ab-biá-te.
Áb-bia-no.

Past.
Sing. Áb-bia a-vu-to, *I may have had.*
Áb-bia *or* áb-bi a-vú-to.
Áb-bia a-vú-to.
Plur. Ab-bia-mo a-vú-to.
Ab-biá-te a-vu-to.
Ab-bia-no a-vu-to.

Imperfect.
Sing. A-vés-si,[1] *I might have.*
A-vés-si.[2]
A-vés-se.
Plur. A-vés-si-mo.
A-vé-ste.
A-vés-se-ro.

Pluperfect.
Sing. A-vés-si a-vú-to, *I might have had.*
A-vés-si a-vú-to.
A-vés-se a-vú-to.
Plur. A-vés-si-mo a-vú-to.
A-vé-ste a-vú-to.
A-vés-se-ro a-vu-to.

I. REMARKS ON THE INDICATIVE MOOD.

1. The purists write *ò*, *ài*, *à*, and *ànno* in the place of *ho*, *hai*, *ha*, and *hanno*, as mentioned already. Baretti says: "They save some ink by so doing."

2. The terminations of the imperfect tenses of *all* Italian verbs in *-era* have a close *e*—thus, *-é-ra*; for example, *fa-cé-ra*, I did; *di-cé-va*, I said, etc. *Va* is the termination of the first and third person, and *-vi* of the second person singular in the imperfect tense of *all* conjugations.

II. REMARKS ON THE SUBJUNCTIVE MOOD.

1. The imperfect tenses of the subjunctive mood, and of the second conjugation (to which *avere* belongs), ending in *-essi*, always have a close *e*—thus, *-és-si*; for example, *te-més-si*, I might fear; *cre-dés-si*, I might believe; etc.

2. *Avessi*, thou mightest have (or with *se*—*se tu avessi*, if thou had), is exclusively of the subjunctive mood; while *avesti*, thou hadst, is exclusively of the indicative mood and of the indeterminate preterite.

KEY TO EXERCISES.

Ex. 20.—1. I do it for pleasure, and not as a duty. 2. I took him for an honest man. 3. I speak for your profit. 4. Out of regard for the friend. 5. He prevailed on him by means of threats. 6. He suffers on his account. 7. Many came to him for advice. 8. He comes every day. 9. I say so for your good. 10. I, for my part, should be of opinion. 11. Ah! sir, for mercy's sake do not ruin me. 12. They died in the villas, in the fields, by the roads, and in the houses, by day and by night. 13. I had well nigh fallen. 14. By his advice. 15. He was buried for dead.

Ex. 21.—1. The good fathers and good mothers. 2. The houses of this town are very high and very beautiful. 3. This poor man is always satisfied 4. Our uncle's daughters are very pleased. 5. Henry's mother loves flowers and children. 6. John's friends have arrived. 7. My sister's friends have set out for Rome. 8. The trees in our garden are still very small. 9. These men are always dissatisfied. 10. My cousin's exercises are easy, but my brother's exercises are very difficult. 11. Your cousins are rich, but your sisters are very poor. 12. Hast thou seen the trees and flowers in our garden?

Ex. 22.—1. Gli amici di mio zio sono ricchissimi. 2. Ho spesso veduto questi uomini. 3. I fanciulli della nostra giardiniera sono ragionevoli. 4. Abbiamo trovato le sorelle d'Enrico nella chiesa. 5. I vostri temi sono difficili, ma i temi di Luigi sono molto facili. 6. Avete voi ricevuto questi bei fiori da Giovanni? 7. Ho ricevuto da mio zio un temperino e venti penne. 8. Questa signora ha sette figliuoli. 9. Questo uomo ha quattro figli e due figlie, che sono molto ragionevoli. 10. Abbiamo ricevuto cinque lettere da nostra zia. 11. Il mio amico ha trovato un temperino e otto penne. 12. Cinque via quattro venti.

Ex. 23.—1. Mentz, a town on the Rhine. 2. Frankfort on the Maine. 3. In the very act. 4. I promise you upon my faith. 5. Upon this earth. 6. Upon some table. 7. I should not be able to give you an answer upon such a point. 8. The trunks are on the carriage. 9. He has wept over his misfortune. 10. He has no claim whatever on my gratitude. 11. You may rely upon my word. 12. The house faces the street.

13. At the break of day. 14. Towards evening. 15. At midnight. 16. Among friends one may speak unreservedly. 17. The most unfortunate among fathers. 18. That must remain between us; we must keep it to ourselves. 19. I said within (to) myself. 20. He will come within ten days.

Ex 24.—1. I miei fratelli sono tristissimi. 2. Hai tu veduto i nostri bicchieri e le nostre bottiglie? 3. Dove sono i vostri fazzoletti ed i nostri? 4. Ho dato a questo povero fanciullo le mie penne e le tue. 5. Mio padre ha venduto i suoi cani ed i miei. 6. Avete voi anche venduto i vostri? 7. Tua moglie ha comprato dieci bicchieri, e quattro bottiglie per sua figlia. 8. Tutte queste bottiglie sono di nostro zio. 9. Amo tutti questi bei fiori. 10. Penso tutti i giorni a Carlo. 11. Ho veduto tutta la città. 12. Luigia è partita con tutte le sue amiche.

ACOUSTICS.—IV.

[*Continued from p.* 41.]

WAVE MOTION — LISSAJOUS' FIGURES — VIBRATION-FREQUENCY AND PITCH—RANGE OF THE HUMAN EAR—THE SIREN SCALES IN MUSIC—CONCLUSION.

A SONOROUS vibrating body, such as a tuning-fork, vibrates with a motion which is very nearly a *simple harmonic motion*, which we may define as the motion of the projection of a point which moves uniformly on a circle, the projection being on a diameter of the circle. A particle of air when transmitting a simple sound, moves in a similar way. If a curve be plotted, connecting *amplitude* and *time* from any selected starting-point, the resulting curve will be of the kind known as a curve of sines, one of which is roughly represented in Fig. 35. We may remark in passing that if two such curves be drawn representing respectively the motions corresponding with the transmission of two notes of, say, nearly the same vibration-frequency, and if the corresponding ordinates of these two curves be added, a new curve will be obtained, which will show clearly the reason of "beats" in music.

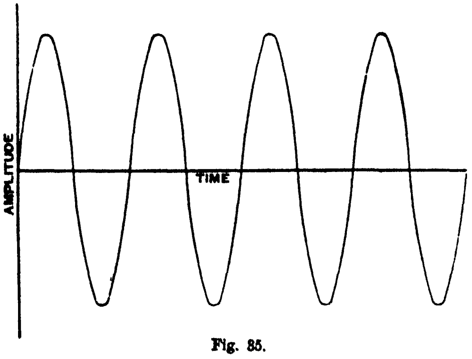

Fig. 35.

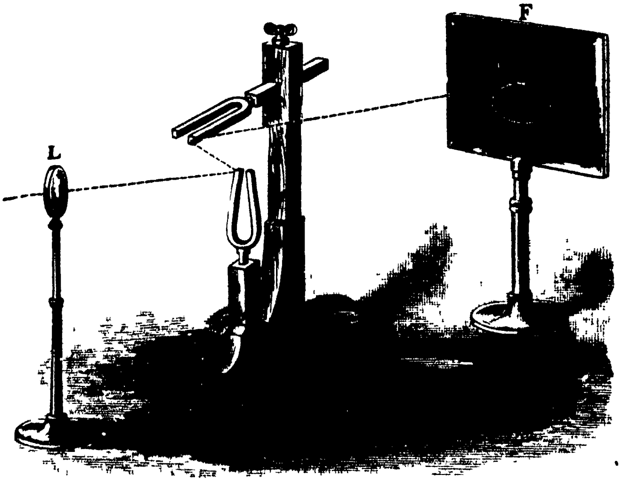

Fig. 36.

Two simple harmonic motions can be combined, and it would be easy, did space permit, to give a graphic method of drawing the resulting figure. Lissajous did this optically. He caused a beam of light to fall on a small mirror attached to the prong of a tuning-fork, the beam after reflection passing on to another mirror fixed to the prong of another fork which vibrated in a plane at right angles to the plane of the first, the beam being then thrown upon a screen. The arrangement is shown in Fig. 36. The resulting figure depends, of course, on the relation between the vibration rates of the two forks, *i.e.*, between the notes produced by them. Fig. 37 shows some of the figures produced when the forks give such simple combinations as unison, octave, or fifth. Similar curves have been obtained by mechanical contrivances which combine two simple harmonic motions.

VIBRATION-FREQUENCY AND PITCH.

The question now suggests itself, how many vibrations per second are necessary to produce a given tone or note? Duhamel roughly computed this by counting the number of vibrations per second made by a fork which emitted a certain note. His method was to attach a light style to the prong of the fork, and let the style trace a sinuous line on a smoked cylinder which rotated with a known speed. The apparatus is shown in Fig. 38. It is called the vibroscope. The total number of waves traced in one revolution, divided by the time in seconds occupied in completing the revolution, will give the number of vibrations per second of the fork. The difficulty seems to lie in maintaining a constant rate of rotation, and hence acoustical methods have been resorted to with greater success. Optical methods, like those of Messrs. Clarke and McLeod already referred to, afford extremely delicate tests of minute differences in pitch due, say, to rise of temperature.

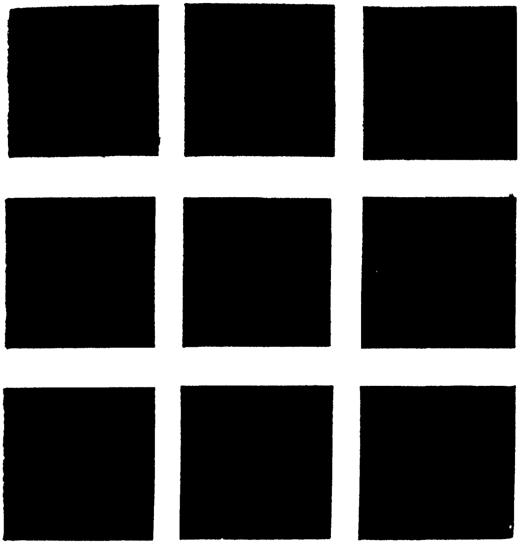
Fig. 37.

As acoustical methods are more general, we shall briefly refer to some of them.

A very rough method was devised by Savart, and is shown in Fig. 39. It consists of two wheels, A and B, mounted in a frame, the larger, A, being turned, and hence producing a rotatory motion of the toothed wheel B driven by it. A piece of card fixed to the plate E touched the teeth of this wheel, and hence was set in vibration as the wheel revolved, these vibrations giving rise to a more or less musical sound or note. When a note of a certain pitch was obtained, the rate of revolution of the wheel B was determined by the speed indicator H, and hence, the number of teeth in B being known, the number of vibrations per second was readily found. This was but a crude apparatus, and has now given place entirely to the siren, an instrument which has been brought to great perfection in the hands of such eminent men as Seebeck, Helmholtz, and Koenig. The essential parts of the instrument, as devised by Cagniard de Latour, are shown in Fig. 40. It consists of a wind-chest, the top plate of which has a certain number (generally 15) of equidistant cylindric holes ranged in a circle round it. There is a circular disc just over this; this disc being freely mounted on a vertical axis and having the same number of holes in it similarly placed, the holes being inclined in different directions in the disc and plate. Hence, when the wind issues with force from the wind-chest, the disc is caused to rotate by the wind impinging on one side of the sloping hole in the disc. The instrument is driven by means of bellows, and as the disc rotates, a number of puffs of wind are emitted, owing to the alternate opening and closing of the set of double holes. These puffs give rise to a note which is higher in pitch as the speed of the disc becomes greater.

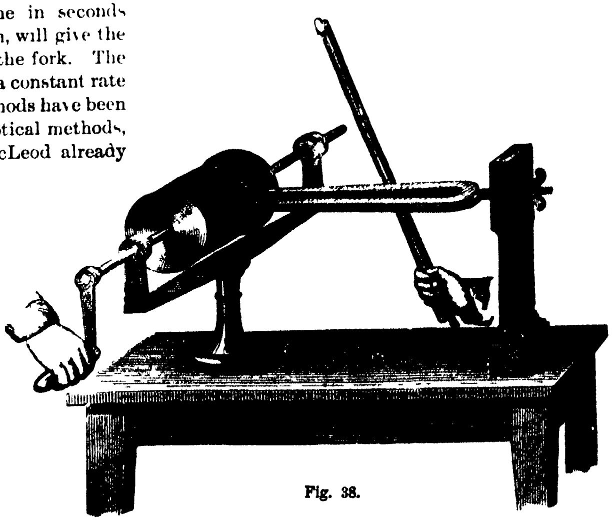
Fig. 38.

The axis of the revolving disc is furnished with a counter which can be thrown in or out of gear at pleasure by pressing one of the buttons seen near the top of the instrument; thus the number of revolutions per second corresponding with the emission of a steady note is observed, and the number of puffs will be 15 times this if there are 15 holes in the circle. Each revolution therefore gives rise, in this case, to 15 vibrations, and the number of revolutions being known, the number of vibrations per second can easily be determined.

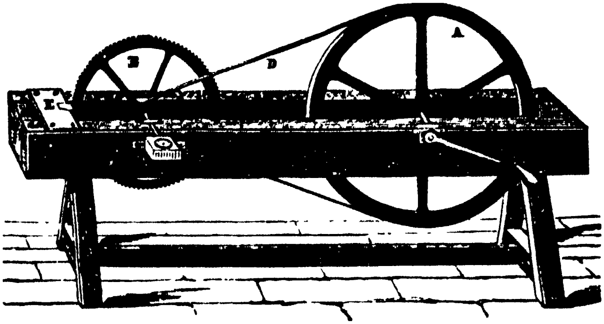

Fig. 39.

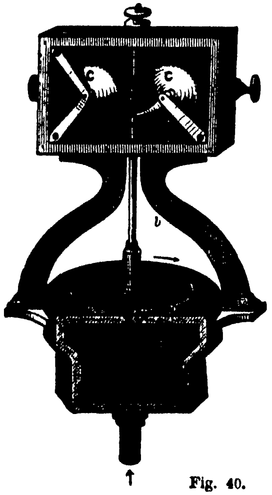

Fig. 40.

Helmholtz's more complicated apparatus is shown in Fig. 41.

Dr. Koenig has constructed an exceedingly elaborate siren for his researches on the phase relations of different tones. It is shown in Fig. 42.* On a single axis are mounted no less than 16 brass discs cut at their edges into sinusoidal wave-forms. These represent an harmonic series of 16 numbers of decreasing amplitude. Against the edge of each of the 16 discs wind can be separately blown through a slit. This instrument, therefore, furnishes a fundamental sound with its first fifteen pure harmonics. Any desired combination can be obtained by opening the appropriate stops on the wind-chest, and there are ingenious arrangements for varying the phases of any of the separate tones by shifting the positions of the slits.

In this way Dr. Koenig made very valuable researches on the connection between difference of phase and intensity, and other matters connected with the physical basis of music, which are, however, beyond the province of the present lesson.

The question may now be asked, how many vibrations per second are requisite in order to produce a distinct musical sound? To this we cannot give a decided answer, since different ears are found to vary considerably in their power of appreciating sounds. To ascertain the limit, Savart slightly modified his apparatus, removing the toothed wheel, and substituting for it an iron bar, which passed between two thin wooden plates, so placed as almost to touch it. When the bar passed between them, a grave sound was produced by the displacement of the air, and he imagined that a distinct but very deep sound could be perceived when the number of these pulsations was about 12 or 14 per second. Other observers have placed the number as high as 32, while some place it as low as 8.

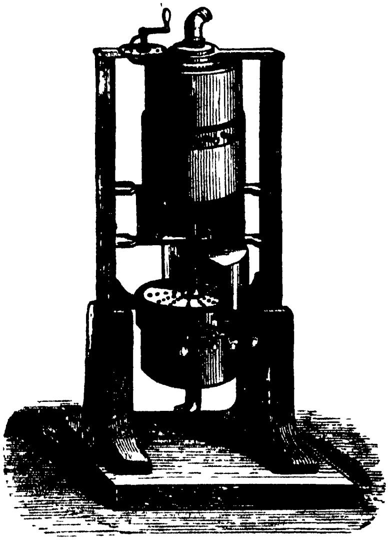

Fig. 41.

The upper limit to the number of vibrations that can be heard also varies very considerably. It depends partly upon the intensity of the vibrations and their amplitude. Some place the limit at from 20,000 to 24,000 vibrations per second; there seems, however, little doubt that a sound corresponding to 38,000 vibrations is audible to most ears. By experimenting with very acute sounds, Dr. Wollaston found that the limits of hearing in different people varied greatly. He sounded a series of small pipes in succession, before a number of people, and found that frequently the ascent of a single note produced to some the change from sound to complete silence; and while some experienced a sound of penetrating shrillness, others were quite unconscious of any sound whatever.

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* By the kind permission of Dr. S. P. Thompson, F.R.S., this figure is copied from the report of his lecture already referred to.

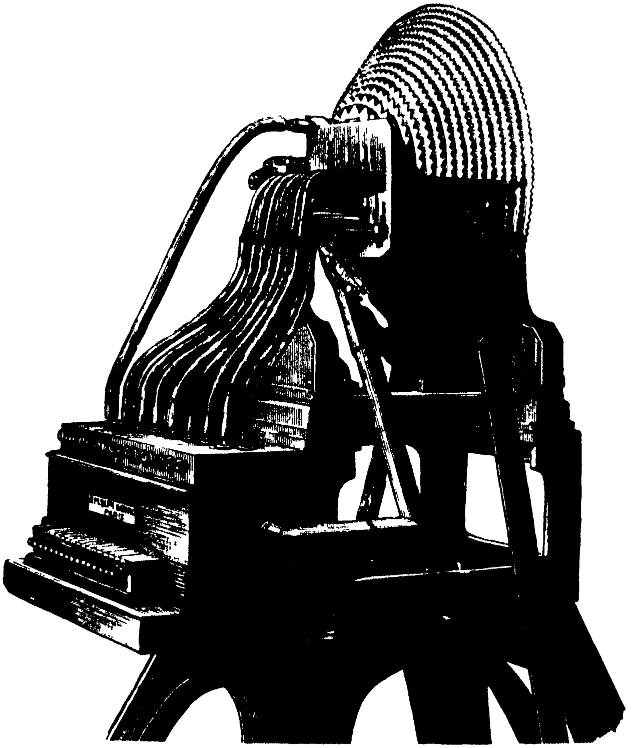

Fig. 42.

There are in Nature sounds so shrill that they are beyond the hearing of many people: thus, for instance, the needle-like cries of the bat are unheard by many; some, too, fail to hear the chirp of the cricket.

We may say, then, that sounds which the ear can distinguish range between 14 and 40,000 vibrations per second. The practical range of musical sounds is, however, much more limited. The deepest sound produced by any musical instrument appears to require about 28 vibrations, and the highest note, which is probably the upper D of the piccolo flute, requires 4,752 vibrations. For ordinary purposes, however, the range is from 40 to 4,000 vibrations, that is, a compass of about seven octaves.

STANDARDS OF PITCH.

Old pitches were flat. For instance, the pitch adopted in Handel's time was probably from C 500 to C 512; what is known as Handel's C being probably about C 500. Then we have the French normal pitch of C 514 to C 527 of about forty years ago, the pitch rising to what has been called the medium pitch of C 520 to C 536. Our modern high pitches are above 536.

QUALITIES OF MUSICAL SOUNDS.

In musical sounds there are three distinct qualities which we may observe; these are:—

1. The *pitch* of the note.
2. Its *intensity*.
3. Its *quality*; or, as it is technically termed, its *timbre*.

The first of these has already been explained to depend upon the number of vibrations made by the sounding body in any given time.

The intensity of the sound depends, not on the number of vibrations, but on their amplitude. The harder we strike a sounding body, or the more vigorously we pluck a string, the greater will be the amplitude of the vibrations produced, and therefore the greater the intensity of the sound. Our ears are, however, so constructed as to be more susceptible to sounds of high than of low pitch, hence a note of low pitch must have much more energy of vibration than a high one to appear equally *loud* to the ear. The *loudness* of two notes or sounds is *not* therefore measured exactly by the energy of the sonorous vibrations at any point.

The third quality of sound—namely, its *timbre*—is very difficult to explain; indeed, it is as yet but imperfectly understood. If we strike any note—

as, for instance, middle C—on a piano, and then sound the same note on a flute or an organ, or utter it with the voice, we shall in an instant notice a great difference between the sounds. They all utter the very same note, producing the same number of vibrations per second; perhaps all had exactly the same intensity, but yet there is a difference, which at once renders itself manifest. This is known as the *timbre.* The quality and shape of the sounding body, and many other points, which are only practically important to musical instrument makers, influence this greatly. Tyndall, in his admirable "Lectures on Sound," to which we are indebted for several facts and which we recommend all our readers to study, employs the word "Clangtint" (the equivalent of the German *Klangfarbe*) to represent this quality. It seems to depend upon the *form* of the sound waves and upon the production of various other tones, in addition to the fundamental one. These over-tones unite with and modify the vibrations produced.

Two musical notes are said to be in unison when both produce the same number of vibrations per second; it is quite immaterial by what instruments they are produced. Sounds may be produced by any number of vibrations; it is found, however, that there is a series of notes arranged at certain fixed intervals which produce the most pleasing music. This series seems to depend on the natural constitution of the human ear, and is known as the Musical Scale, or Gamut.

It consists of a series of seven notes, designated in England by the letters C, D, E, F, G, A, B, and on the Continent by the names *ut* or *do*, *re*, *mi*, *fa*, *sol*, *la*, *si*. The same series is then reproduced, each note being produced by double the number of vibrations. The annexed table will show clearly the relative number of vibrations required to produce these notes. A second C is inserted to complete the octave:—

NAME.			RELATIVE NUMBER OF VIBRATIONS.
C	or	*do.*	1
D	,,	*re.*	[illegible]
E	,,	*mi.*	[illegible]
F	,,	*fa.*	[illegible]
G	,,	*sol.*	[illegible]
A	,,	*la.*	[illegible]
B	,,	*si.*	$\frac{15}{8}$
C	,,	*do.*	2

The first C given here is that known as middle C, and the number of vibrations for any higher or lower C can easily be found by multiplying or dividing by 2, 4, 8, etc., according to the number of octaves intervening. The C referred to above, in connection with "standards of pitch," is the last on this list. The length of the sound-waves corresponding to each note may easily be found by dividing 1,120 feet by the number of vibrations.

By comparing the fractions above given we shall find that the intervals between the notes are nearly, but not quite, uniform. There are three different intervals represented by the fractions $\frac{9}{8}$, $\frac{10}{9}$, and $\frac{16}{15}$, and called respectively a *major tone*, a *minor tone*, and a *major semitone* or *limma.* The latter is the interval between E and F, and between B and C, and is not divided, as the other intervals usually are, by the insertion of intermediate notes known as flats and sharps.

By sounding different notes simultaneously, we find that some combinations produce a much more pleasing effect than others. The most pleasing result is attained when one is just an octave above the other, and consequently produces twice the number of pulsations. In this case, every other pulsation of the higher note corresponds with one of the lower. This interval is called an *octave*, because in the gamut any note is the eighth above the previous one of the same name.

Next to the octave, the most pleasing chord is produced when three pulsations of the one note correspond to two of the other. This may be produced by sounding together C and G, and is known as a *fifth.* If we sound G and the C above it we shall obtain the combination known as a *fourth*, in which four vibrations of one correspond to three of the other. Both these are represented in Fig. 43.

The other concords are known as the *major third*, in which the ratio is 5 : 4, and the *minor third*, in which it is 6 : 5. These may respectively be produced by striking together C and E, and E and G. When the numbers representing the ratio are high—as for instance, 13 : 14—we get unpleasant jarring sounds or discords.

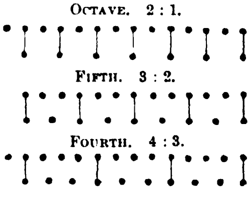

Fig. 43.

A perfect chord is produced when three notes are sounded together whose vibrations bear to one another the ratio 4 : 5 : 6. Illustrations of this may be obtained by sounding C, E, and G, or G, B, and D.

Before concluding these lessons we must just briefly notice the construction of that most wonderful and important of all acoustic instruments—the human ear. (*See also* "The Organs of Sense.")

The external ear is so shaped as to convey the pulsations of the air to a circular membrane, known as the tympanum. Behind this is a small cavity known as the drum of the ear, across which there stretches a chain of four small bones. At the further side of the drum are two apertures, also closed by membranes; through these the vibrations are conveyed to a remarkable cavity hollowed out of the bone. This cavity, which is known as the *labyrinth*, is filled with water, and the ramifications of the auditory nerve are distributed over its surface. In certain parts of it minute bristles project, and in another part we have minute crystalline particles called *otolithes*, all of which seem specially fitted to receive the faintest vibrations. A remarkable organ has further been discovered by Corti; this consists of a vast number of vibrating cords, each of which is apparently tuned to receive and render audible some special vibrations. The intimate structure of these delicate organs is, however, as yet but imperfectly understood; further investigation will doubtless serve to throw much fresh light on the whole subject; but the way in which external sensations of any kind are communicated to the brain is at present more or less a matter of speculation.

We have endeavoured in the space at our disposal to bring before the reader the leading facts and laws of the science of Sound. We trust that the student has obtained from these lessons a good groundwork for, and a stimulus to, a more extended study of this interesting subject, and that the casual reader has found in these pages interesting and useful matter.

MENSURATION.—I.

Mensuration is a comprehensive and general term signifying the determination of the extent both of lines, surfaces, and solids, and is derived from the Latin word *mensura*, a measuring; and it is our purpose to explain in the following chapters, as simply as possible, the rules by which the science is governed.

In our treatment of Geometry (which is, after all, but a branch of Mensuration) we have explained what are the relations, proportions, and properties of lines and surfaces. Under the head of Mensuration we shall show the mode of estimating the lengths, surfaces, and capacities formed by lines and angles. And herein lies the difference between the two subjects, for whilst Geometry simply treats of the general relations of lines and angles, Mensuration enters into the methods for determining their length and extent in individual cases, Geometry providing us with the theories which Mensuration applies practically.

In order to avoid repetition, we will refer our readers to our chapters upon Geometry for the definitions which are necessary to be understood in studying the subject of Mensuration.

It will strike every person upon reflection that all measurements must be included under four distinct heads: the first, of *lines;* the second, of *angles*, that is, of the inclination of two *straight* lines to each other which meet; the third, of *surfaces*, that is, of spaces included or shut in by lines, but devoid of thickness; and the fourth, of *solids*, that is, of bodies possessed of length, breadth, and thickness. Everything possessed of magnitude can be classed under one or other of these four distinct heads, and we propose to adopt the order in which we have stated them in our consideration of measurements generally.

And first as to *lines*. The measurement of lines, which at first sight appears a very simple process, is by no means so easy a matter as it appears. We are, of course, speaking not of *approximate*, but of *correct* measurement. It is by no means easy to ensure *perfect* uniformity—*undeviating* equality—in the length even of the self-same thing. The dimensions of all bodies are affected in a greater or less degree by differences of temperature, and however minute this difference may be, yet when the body or instrument so affected is intended to be used as a standard or guide wherewith to measure other and longer lines, an error, however trifling, becomes speedily magnified until it has grown serious.

Our national standards of measurement are on this account most scrupulously protected, and if required for reference must be used with the greatest caution, particularly as regards temperature.

It is not, however, necessary in the ordinary routine of business to be so minutely exact as, for instance, to bring a powerful microscope to bear upon the point where the rod, rule, or chain has to repeat itself in order to secure perfect coincidence at the point of meeting. Indeed, in the use of that valuable measurer of length, the Gunter chain—an instrument we shall have again to refer to—a man accustomed to the work will bring its back extremity so nearly to coincide with the point where the front end of the chain has touched, that after many hundred repetitions of the operation, a second measurement by calculation will detect but a few inches of difference.

In measurements based on the Metric System,

which system is now adopted in all scientific work, the metre is the standard:—

$\frac{1}{1000}$ metre = 1 millimetre.
$\frac{1}{100}$ metre = 1 centimetre.
$\frac{1}{10}$ metre = 1 decimetre.
10 metres = 1 decametre.
100 metres = 1 hectometre.
1000 metres = 1 kilometre.

In measurements of length, when the distance to be measured is trifling, recourse is had to a foot rule, a yard measure, or a ten-foot rod; but in longer distances, the measurement of land for instance, the Gunter chain is employed, for reasons which will be explained when we come to treat of land surveying. This chain consists of 100 iron links united by iron rings. The full length of the chain is 66 feet, consequently each link and its accompanying ring is $\frac{66}{100}$ of a foot in length, or 7·92 inches. Every ten links from either end is distinguished by a brass label having one or more notches cut in it, the number of notches corresponding to the number of tens from the end nearest it, and the middle or fiftieth link having a circular piece of brass attached to it. These marks are intended to save time and trouble in counting the number of any particular link from the extremity of the chain.

Another point for consideration in measuring accurately a long line is to guard against any deviation from its intended route. If it be a *straight line*, the course throughout must be absolutely straight, and to accomplish this it will be necessary either to fix upon a given landmark of small lateral dimensions which lies exactly in the intended line, and to direct each successive extension of the chain upon this point by the eye from the back end of the chain, or previously to stake out by means of rods the line of route, and to be careful that the chain lies always evenly along that line. In the measurement of a curved line, the rods employed to stake it out must stand sufficiently close together as that an almost inappreciable difference shall exist between the straight lines which connect them and the curve of which they form a part. Correctness in measurement of lines is absolutely essential to correctness in the measurement of the spaces enclosed by them; this fact cannot be too carefully borne in mind.

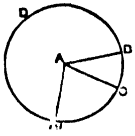

Fig 1.

Our next step is the consideration and measurement of the inclination of two straight lines to each other which meet—that is, of the angle formed by their meeting or intersection. Mensuration in this respect is simply the application of arithmetic to trigonometry. We shall not at present go deeply into the subject of trigonometry, but merely explain the rules upon which the measurement of angles is based.

It is proved by geometry that the angles at the centre of a circle bear to one another the same proportion as the arcs, or portions of the circumference of the circle which the lines forming the angles cut off from it, do to one another.

In Fig. 1, let B C D be a circle of which A is the centre, and let the line A B be drawn, and suppose it fixed. It is evident that, as from the centre of a circle any number of lines or radii can be drawn to the circumference, we can draw A C, A C′ in any position we please, and thus form any number of angles B A C, B A C′ at the point A. Now the *measure* (or size) of these angles is estimated, not by the lines which form them, as A B, A C, A C′, but by the arcs of the circle these lines cut off; thus, the measure of the angle B A C is the arc B C, and so on. It is, therefore, only necessary to adopt some method of dividing these arcs in order to measure arithmetically the angles they represent.

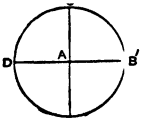

Fig. 2.

Now it has been decided that every complete circle shall be considered as divisible into 360 equal parts, each of these parts to be called a degree; again, each degree shall be divisible into sixty equal parts, called minutes; and each minute into sixty equal parts, called seconds. The division can be carried further, but it is not usual to extend it beyond seconds. The signs by which these several divisions are recognised are —A degree, by °; a minute, by ′; and a second, by ″; thus 23° 12′ 10″ would read twenty-three degrees, twelve minutes, ten seconds.

In the French method of reading angles, a right angle consists of 100 grades, a grade of 100 minutes, and a minute of 100 seconds; thus 24ᵍ 7′ 95″ would read twenty-four grades, seven minutes, ninety-five seconds.

By the 10th Definition of the First Book of Euclid, it is stated that when a right (or straight) line standing upon another right line makes the adjacent angles equal to each other, each of these is called a right angle. This condition of two lines is shown in Fig. 2, in which the line A C stands upon the line D B so as to make the adjacent angles B A C, D A C equal; and in this case each of these angles is called a right angle. Again, by the 14th Proposition of the First Book of Euclid it is shown that if at a point in a right line two other right lines upon opposite sides of it make the adjacent angles equal together to two right angles, these two lines shall be in one straight line. So, by reference to Fig. 2, if at the point A in the line A C, the two right lines A B, A D upon opposite sides of it make the adjacent angles B A C, D A C equal to two right angles, the lines A B, A D shall be in one straight line; and it has been assumed that in this figure these adjacent angles are equal to each other, and are equal to two right angles. Therefore, the line D A B is a straight line, and as it passes through the centre of the circle B C D it clearly bisects the circle, that is, it cuts it into two equal parts or hemispheres. From this we gather that two right angles together measure the number of degrees contained in half a circle, or $\frac{360}{2}^\circ = 180^\circ$, and hence one right angle measures $\frac{180}{2}^\circ = 90^\circ$.

There is another fact our readers must bear in mind. It has been stated that *the arc is the measure of the angle*; but the measurement of this arc in degrees, minutes, etc., is quite independent of the size or radius of the circle of which it is the arc.

We will prove this. Let A (Fig. 3) be the common centre of the two circles, B C D and B′ C′ D′, of which the circle B′ C′ D′ is double the diameter of the circle B C D, and let the two straight lines A B B′, A D D′ be drawn from A to cut the two circles at B B′ and D D′ respectively. Assume the angle B A D equal to 60°, then D B is its measure; but evidently the angle B′ A D′ is identical with the angle B A D, and is therefore equal to 60°, and B′ D′ is its measure. Hence, although B′ D′ is double the length of B D, it yet measures only the same number of degrees.

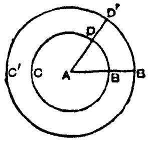

Fig. 3.

Any two angles which together make up 90° are called *complements* of one another—thus 25° is the complement of 65°; and any two angles which together make up 180° are called the *supplements* of one another — thus 80° is the supplement of 100°.

The next step will bring us to the consideration of *triangles*. This word, derived from the Latin *triangulum*, implies a figure having three angles, and which must therefore have three sides. It is at once evident that this subject introduces a third element of measurement, namely, *surface*, or superficies. We have treated of *lines*, the measure of which is expressed in inches, feet, yards, chains, etc. We have shown how *angles* are formed by lines, and have explained that the measure of angles is expressed in degrees, minutes, etc. We now add a third element, namely, *surface*. So long as only *two* straight lines were involved, we could include no definite space or surface within them, but the addition of a third line so as to form a triangle at once limits the lengths of the first two, and encloses a space.

We will first glance at the relations which the several lines and angles of a triangle occupy with respect to each other, but must of necessity refer the student to our papers on Geometry for many introductory points connected with our present subject.

Euclid has proved, in the 32nd Proposition of his First Book, that the three interior angles of every triangle are together equal to two right angles, that is, to 180°. Let the reader bear this fact in mind. Hence it follows that if the measures of any two angles of a triangle be known, the third angle can be found by simple subtraction. For instance, in the triangle A B C (Fig. 4), let the angle A B C equal 75°, and the angle B C A equal 45°, the sum of these two angles will be 75° + 45° = 120°. Then subtract 120° from 180° (the measure of two right angles), and the remaining 60° will be the measure of the angle B A C.

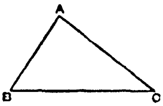

Fig. 4.

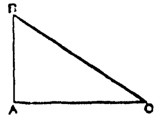

Fig. 5.

There are some remarkable facts in connection with that particular kind of triangle called a *right-angled* triangle which we will state here, as being calculated to introduce the further consideration of the subject to our readers.

In his 47th Proposition of the First Book, Euclid has proved the wonderful fact that in every triangle having one angle a right angle, *i.e.*, 90°, the space enclosed by a square constructed upon that side of the triangle opposite the right angle is equal to the sum of the two squares constructed upon the other sides respectively.

The three sides A B, A C, B C may be called severally the perpendicular, the hypothenuse, and the base of the right-angled triangle A B C.

Let A B C (Fig. 5) be a right-angled triangle, of which B A C is the right angle. Then a square constructed upon B C will equal in area the squares constructed upon the two sides A B and A C added together. The general formula, or expression, for this interesting problem is (referring to Fig. 5) $BC^2 = AB^2 + AC^2$, and therefore $BC = \sqrt{AB^2 + AC^2}$. In this case we suppose the lengths of A B and A C to be known, and from the above equation B C can be found.

Again, suppose B C and A C to be known, then by transposing the equation, and keeping the unknown side by itself, we have $AB^2 = BC^2 - AC^2$; therefore $AB = \sqrt{BC^2 - AC^2}$; and so by another transposition we can find A C, provided we know the lengths of A B and B C. Hence we arrive at the general and important fact that in every right-angled triangle, if we know the lengths of any two of its sides, we can by simple calculation find the third.

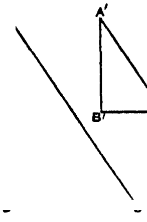

Fig. 6.

Now this fact can be made use of in a variety of ways We must first refer the reader to the 4th Proposition of the Sixth Book of Euclid, in which it is stated and proved that in equiangular triangles the sides about the equal angles are proportional. For instance, in Fig. 6 let the two triangles A B C and A' B' C' be equiangular, the angle A being equal to the angle A', B to B', and C to C'; then A B is to A' B' as B C is to B' C'. Again, suppose these triangles to be contained, the lesser within the greater, as shown in Fig. 7, and let B' and B be the right angles. Now since the angles A' B' C and A B C are both right angles they are equal to each other, and the angle at C is common to both; hence the angle B A C is equal to the angle B' A' C, and the two triangles have the sides about the equal angles proportional, that is, A' B' is to A B as B' C is to B C. But it is a well-known fact of proportion that whenever three quantities are known, the fourth can be found. Hence if A' B', B' C, and A B be known, the length of B C can be found.

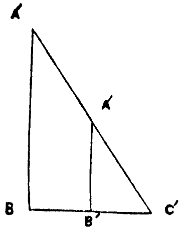

Fig. 7.

This rule can be applied to practical use in the following manner:—

Suppose we wish to ascertain the height of a building whose base we can reach. Measure with a chain or other suitable instrument, a certain distance from the foot of the building. Then, at a certain distance from this point, and between it and the building, erect a perpendicular rod, whose length is known, and let it stand at such a point as that the line of sight between the distance measured and the summit of the building shall exactly pass over the top of the rod. Then measure the distance from the bottom of the rod to the above-named point, and by the rule of three the height of the building can be ascertained.

In Fig. 8 let B C represent any building whose height it is desirable to ascertain. Measure a given distance from B to A, of say fifty feet, then place the rod B' C' at a certain point along the line A B, so that the line of sight from A to C exactly touches the point C' of the rod. Let this point be at B', say fifteen feet from A, and let the length of the rod B' C' be twelve feet; then A B' is to A B as B' C' is to B C, or arithmetically –

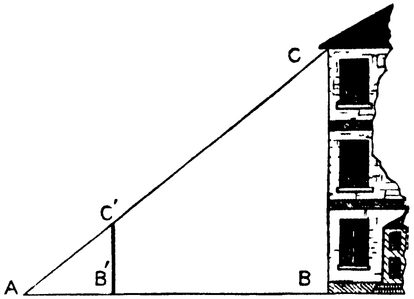

Fig. 8.

$$\begin{array}{ccccccc} AB' & : & AB & :: & B'C' & : & BC \\ 15 & : & 50 & :: & 12 & : & 40 \end{array}$$

that is to say, the height of the building is forty feet.

Again, suppose a building whose height is known stands upon the edge of a river whose breadth we desire to know. Upon the opposite brink of the river fix a rod of a known height perpendicularly, and let the observer retire from the river until his line of sight from the ground level places the top of the rod in coincidence with the summit of the building. Then measure the distance from the foot of the rod to this point, and by the rule of three we obtain the breadth of the river.

In Fig. 8 let B C be a building whose height is known to be forty feet. Let B' B be the river flowing between the observer at A and the building. Then plant the rod B' C' perpendicularly upon the brink of the river, and let A be the point where the line of sight A C strikes the top of the rod. Let the height of the rod be twelve feet, and the distance from A to B' be found to be fifteen feet; then—

$$\begin{array}{ccccccc} B'C' & : & AB & :: & BC & : & AB \\ 12 & : & 15 & :: & 40 & : & 50 \end{array}$$

but $AB' = 15$ feet, therefore $B'B = 50 - 15 = 35$ feet, the breadth of the river.

So also in similar rectilineal figures of any number of sides, the several angles are equal, and the sides about these equal angles are proportional.

SPANISH.—IV.

[Continued from p. 44.]

INTERROGATIVE PRONOUNS.

THE interrogative pronouns are the same as the relative, except that *cual* is used without being preceded by the article. They are not used in precisely the same manner; for in interrogations, quien always means *who;* cual, *which;* que, *what;* cuyo, *whose;* as—

¿Quien tiene hambre?*	*Who is hungry?*
¿Quienes tienen sed?	*Who are thirsty?*
¿Cual de los hijos está allí?	*Which of the sons is there?*
¿Que dijo el médico?	*What said the doctor?*
¿Que sombrero tiene V.?	*What hat have you?*
¿Cuyos libros son estos?	*Whose books are these?*
¿De quien son estos libros?	*Whose (or of whom) are these books?*

When the interrogative pronoun is governed by a preposition, the answer to the question must always be preceded by the same preposition; as—

¿De quien son aquellos niños? De Juan.	*Whose are those children? John's.*
¿Para quien lo hizo? Para la muger.	*For whom did he do it? For the woman.*

When *what* is used in ejaculatory interrogations, as, "What a fine day!" the indefinite article is omitted in Spanish; as—

¡Que hermosa mañana!	*What a fine morning!*
¡Que desgracia!	*What a disgrace!*

In Spanish all that is necessary to form an interrogative sentence is to place the interrogation mark before (inverted) and after the sentence. Thus, Juan tiene dinero, means, *John has money;* and ¿Juan tiene dinero? means, *Has John money?* It is, however, common (though not necessary) in Spanish, to place the nominative after the verb in interrogations; as—¿Tiene Pedro dinero? ¿tienen los pintores libros? *Has Peter money? have the painters books?*

The auxiliary verb *do* is unknown in Spanish (as also in all the languages of Europe except the English), and all such expressions as *Does John speak? do they love? how much do you ask a week? Peter did speak,* must be rendered in Spanish by the simple form of the verb; as—¿Habla Juan? ¿aman ellos? ¿cuanto pide V. por semana? Pedro habló; that is, *speaks John? love they? how much ask you per week? Peter spoke.*

VOCABULARY.

Água, *water.*
Azúcar, *sugar.*
Boton, *button.*
Dice, *(he) says.*
Dicen, *(they) say.*
Dijo, *(he) said.*
Entiende, *(he) understands.*
Espécie (f.), *species, sort.*
Habla, *(he) speaks.*
Manteca, *butter.*
No, *no, not.*
Pan, *bread.*
Quiere, *(he) wishes, (he) wants.*
Quieren, *(they) wish, (they) want).*
Rico, *rich, noble, delicious.*
Señor, *sir*
Señora, *madam, lady.*
Sí; *yes.*
Toma, *(he) takes.*

MODEL SENTENCES.

¿Quien tiene azúcar? *who has sugar?*
¿Quien habla Ingles? *who speaks English?*
¿Cual de los dos pintores tiene dinero? *which of the two painters has money?*
¿Que dijo la hija del juez? *what said the judge's daughter?*
¿Que libro tiene V.? *what book have you?*
¿De quien es el tesoro? *whose is the treasure?*
¿Quiere su hijo pan, señor? *does your son want bread, sir?*
No, señor, mi hijo tiene pan, *no, sir, my son has bread.*

EXERCISE 15.

Translate into English:—

1. ¿Quien es bueno? 2. ¿Quienes son ricos? 3. ¿De quien son las casas? 4. ¿Cuyos libros tiene V.? 5. ¿Que dijo V.? 6. ¿Que sombrero tiene V.? 7. ¿Que tesoros halló Pedro? 8. ¿Que lengua habla el general? 9. ¡Que hombre es V.! 10. ¡Que hermosa muger! 11. ¿Quien quiere pan? 12. ¿Quien habla Español? 13. ¿Quien entiende el Ingles? 14. ¿Quien ama la verdad? 15. ¿Quien entiende lo que Juan dice? 16. ¿Que espécie de botones quiere V.? 17. ¿Que espécie de azúcar tiene Pedro? 18. ¿Que quieren VV.? 19. ¿Que libros quieren los pintores? 20. ¿Que dicen los jueces? 21. ¿Que dijo el hermano del médico? 22. ¿Señora, quiere V. manteca? 23. ¿Entiende su hija de V. el Ingles, señora? 24. No, señor, ella no entiende el Ingles. 25. ¿Cuyos botones tienen los criados? 26. ¿Quien tiene hambre? 27. ¿Quienes tienen sed? 28. ¿Que espécie de cucharas tienen las hermanas del Americano? 29. ¿Que quieren Pedro y Juan? 30. ¿Quien entiende lo que VV. dicen? 31. ¿Quien tiene pan? 32. ¿De quien son los libros? 33. ¿Cual de los Franceses habla Español? 34. ¿Tiene V. dinero? 35. ¿Tiene V. muchos libros? 36. ¿Tiene el libro hojas de oro? 37. ¿No son sus amigos ricos? 38. ¿Mis hermanos no son mas ricos que los carpinteros de navio? 39. ¿Tienen los criados hambre? 40. Si, señor, los criados tienen hambre.

EXERCISE 16.

Translate into Spanish:—

1. Who is wise? 2. Who is rich? 3. Who are good? 4. Who are culpable? 5. Who is strong? 6. Who are robust? 7. Of whom does John speak? 8. Of the physican. 9. Whose (*of whom*) are the houses? 10. Peter's. 11. Whose books has Mary? 12. Whose buttons have the male servants? 13. Whose spoons have my sisters? 14. Which of the two sons of the physician found a treasure in the road? 15. What say you? (*what says your worship?*) 16. What does John wish? 17. What do the judges say? 18. What hat have you? 19. What do you wish? 20. For whom did John write the letters? 21. For the Frenchwoman. 22. To whom (plur.) did John give the French^2 books^1? 23. To the daughters of the judge. 24. What a woman! 25. What a beautiful city! 26. Who

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* Literally, this is, "Who has hunger?"

wants sugar? 27. Who speaks English? 28. Who understands Spanish? 29. Who understands what Mary says? 30. What sort of spoons have my friends? 31. What do the women say? 32. Do you take water? 33. What did John's sister say? 34. Does your son speak Spanish, sir? 35. Yes, madam, my son speaks Spanish. 36. Whose spoons has the female servant? 37. Whose hat has Peter? 38. Whose buttons have the painters? 39. What books has Mary? 40. What bread have you? 41. Who is thirsty? (*who has thirst?*) 42. Who is hungry? 43. Are you (a) Spaniard? 44. Are the Spanish women thirsty? 45. No, madam, the Spanish women are not thirsty.

DEMONSTRATIVE PRONOUNS.

The demonstrative pronouns are este, *this;* ese, *that;* aquel, *that.* They are thus declined :—

Singular.			*Plural.*		
MASCULINE.	FEMININE.		MASCULINE.	FEMININE.	
Este,	esta,	*this.*	Estos,	estas,	*these.*
Ese,	esa,	*that.*	Esos,	esas,	*those.*
Aquel,	aquella,	*that.*	Aquellos,	aquellas,	*those.*

There is also, in the singular number of each of these demonstrative pronouns, a neuter form, used when we cannot ascribe a gender to it; viz, *esto, eso, aquello.*

Este is used with what is near at hand, as, este hombre, *this man* (here); *ese* with what is somewhat distant, as, ese hombre, *that man* (there); and *aquel* with what is still more distant, as, aquel hombre, *that man* (off there, yonder), When relating to time, *este* is used with time present, *ese* with time past, and *aquel* with time still more distant; as, "this (*este*) book which I now have, that (*ese*) book which I had last week, and that (*aquel*) book which I had last summer, are valuable."

Este refers to the last mentioned of two things, and *ese* (or *aquel*) to the first; as—

El general y el capitan vinieron; ese (*or* aquel) es prudente, este es fatuo.	*The general and the captain came; the former is prudent, the latter is stupid.*

When *este* or *ese* comes before the indefinite pronoun *otro* (other), the former drops its final letter, and the two are joined, forming one word; as, estotro *or* estotra, *this other;* estotros *or* estotras, *these others;* esotro *or* esotra, *that other;* esotros *or* esotras, *those others.*

If the objective case of the relative pronoun *quien* (whom) is used in such phrases as *he whom, she whom, him whom*, etc., *aquel* must come before it; as, aquel á quien, *he whom;* aquella á quien, *she whom;* aquellos *or* aquellas á quienes, *they whom*; as—

Aquellos contra quienes pelearon.	*Those against whom they fought.*

When the relative pronoun of the objective case is not preceded by a preposition, the definite article is generally used instead of *aquel*, and is followed by the relative pronoun *que;* as, el que, *he whom;* la que, *she whom;* los *or* las que, *they whom.* Thus it will be perceived that *he whom* may be rendered either, aquel á quien *or* el que; *she whom*, by either aquella á quien *or* la que; *they whom*, or *those whom*, by either aquellos *or* aquellas á quienes, *or* los *or* las que. The latter mode is most generally employed.

When the objective case of the personal pronouns *him, her*, or *them* precedes the nominative of the relative *who*, either *aquel* or the definite article may be used; as—

Juan dió pan á aquella que tiene hambre, *or* Juan dio pan á la que tiene hambre.	*John gave bread to her who is hungry.*

When in English the demonstrative pronoun *that* is followed by the preposition *of*, and refers to a noun already expressed, the definite article is employed in Spanish; as—

Por su prudencia y por la del juez.	*Through his prudence and through that of the judge.*

The English demonstrative pronoun *that* is rendered in Spanish by the definite article when it refers to something having preceded it, and is followed by the preposition *of;* as—

My house and that of my servant.	*Mi casa y la de mi criado.*
His only desire was that of freeing his country from the Saracen yoke.	*Su único deséo era el de libertar a su patria del yugo sarraceno.*
The soldiers of General Brown are as brave as those of General Canrobert.	*Los soldados del general Brown son tan valientes como los del general Canrobert.*

VOCABULARY.

Ancho, *wide.*
Brisa, *breeze.*
Caballero, *gentleman.*
Cerveza, *beer.*
Cuchillo, *knife.*
Diego, *James.*
Espejo, *looking-glass.*
Facil, *easy.*
Lampara, *lamp*
Librero, *bookseller.*
Londres, *London.*
Lucia, *Lucy.*
O, *or.*
Panadero, *baker.*
Pero, *but.*
Pluma, *pen, feather.*
Posadero, *innkeeper.*
Pronunciacion, *pronunciation.*
Sombrerero, *hatter.*
Tenedor, *fork.*
Vino, *wine.*
Zapatero, *shoemaker.*
Zapato, *shoe.*

MODEL SENTENCES.

Aquellas mugeres tienen prudencia, *those women have prudence.*

Juan hablo á aquella á quien V. vio; *or*, Juan hablo á la que V. vio, *John spoke to her whom you saw.*

EXERCISE 17.

Translate into English :—

1. Este hombre es rico. 2. Aquella muger es soberbia. 3. ¿Habla esa señora la lengua inglesa? 4. ¿Cuyo es este cuchillo? 5. ¿Cuyos son esos tenedores? 6. Aquel á quien mi padre escribió las cartas tiene mucho dinero. 7. Aquella á quien Juan dió un libro es muy hermosa. 8. Esta casa y la que V. vió, son mias. 9. ¿No es este el hijo del panadero? 10. El sombrerero escribió estas cartas. 11. Este

espejo es mio. 12. Este hombre es mi amigo. 13. ¿ Quien es esa muger ? 14. Esta brisa es agradable. 15. ¿ Cuya es esta pluma ? 16. Las cucharas de Lucía y las de María son de oro. 17. Juan no tiene mi libro, pero tiene él de mi hermana. 18. ¿ Tiene V. mis plumas ó las de mi padre ? 19. ¿ Tiene el panadero mi pan ó él del carpintero ? 20. La cerveza del posadero es tan buena como la del zapatero. 21. El vino de Diego es tan bueno como el de Pedro. 22. ¿ Tienen los impresores mis libros ó los de mi amigo ? 23. Los impresores no tienen tus libros, pero tienen los de tu amigo.

EXERCISE 18.

Translate into Spanish :—

1. This gentleman is good. 2. That woman is handsome. 3. Those spoons are new. 4. Those painters are poor. 5. These houses are lofty. 6. Those hats are ours. 7. Whose houses are those ? 8. Who is that gentleman ? 9. Does that lady (*señora*) speak the Spanish² language¹ ? 10. That looking-glass is not old. 11. Are these my shoes ? 12. Whose hat is that ? 13. The Spanish woman and the Englishwoman have prudence ; the former is more amiable than the latter. 14. Those to whom John gave the pens are poor and ignorant. 15. She to whom the hatter gave the looking-glass is poor and proud. 16. Lucy gave the spoons to those whom you saw. 17. The bookseller gave three books to her who wrote him the letters. 18. Is not this the mother of the shoemaker ? 19. Those knives are hers. 20. These forks are his. 21. Who is this lady ? 22. James has not my book, but he has my sister's. 23. The streets of London are wider than those of Madrid. 24. The pronunciation of the French is not so easy as that of the Spanish. 25. My beer is not so good as John's.

INDEFINITE PRONOUNS.

The indefinite pronouns, or, more properly, the indefinite adjective pronouns, are —

Cada, *each.*
Uno, *one.*
Todo, *everyone, all.*
Nadie, *nobody.*
Alguien, *somebody.*
Ninguno, *none.*
Alguno, *some.*
Algo, *something.*
Nada, *nothing.*
Otro, *other.*
Tal, *such.*
Ámbos, *both.*
Entrámbos, *both.*

Of these, *uno,** *todo*, *ninguno,** *alguno,** *otro*, and *tal* are declined like adjectives, both in the masculine and feminine. *Cada*, *nadie*, *alguien*, *algo*, *nada*, are used only in the singular, and do not change. *Ambos* and *entrámbos* are already in the plural, but have their feminine, *ambas* and *entrámbas*.

There are also some indefinite relative pronouns, quienquiera, cualquiera, cualesquiera, *whoever*, *whosoever*, *whichever*, *whichsoever*.

We subjoin a list of these indefinite pronouns, simple and combined, with examples of the manner in which they are employed in Spanish.

The following are always used as nouns, that is, are never joined to a noun :—

Cada uno, *every one ;* cada cual, *each one :—*

Los cuatro animales, cada uno de ellos tenia seis alas.	*The four animals, every one of them had six wings.*
Todos seran premiados, cada cual segun sus obras.	*All will be rewarded, each one according to his deeds.*

Uno otro, *each other :—*

Juan y Diego se aman uno á otro.	*John and James love each other* (*love themselves* one to the other).

Unos otros, *one another :—*

Orad los unos por los otros.	*Pray for one another (the ones for the others).*

Nadie, *nobody, no one :—*

Á nadie ama el avaro.	*The miser loves nobody (to nobody loves the miser).*

Alguien, *somebody, anybody :—*

¿ Le a visto alguien ?	*Has anybody seen him ?*

Uno y otro, *one and the other, both :—*

Uno y otro son amables.	*Both of them are amiable.*

Algo, *something, anything : —*

Yo tengo algo que comer.	*I have something (which) to eat.*

Nada, *nothing, not anything :—*

Nada tengo con que mantenerme.	*I have nothing with which to maintain myself.*

Todo lo que, *all that which, everything, whatever : —*

Esta echo todo lo que tenia.	*This woman cast in all that she had.*

Quienquiera que, cualquiera que, *whoever, whosoever, whichever :—*

Quienquiera que el sea.	*Whatever he may be.*
Cualquiera que se humillare.	*Whoever may humble himself.*

The following are never used alone, but always with a noun :—

Cada, *each, every :—*

Cada vez.	*Each time.*
Cada palabra.	*Every word.*

Cualquier, cualesquier, *whatever : —*

Cualquier criatura.	*Whatever creature.*
Cualesquier criaturas.	*Whatever creatures.*

The following may be used alone as nouns, or joined to nouns as adjectives :—

Todo, todos, *everything, all, everybody, every :—*

En todo dad gracias.	*In everything give thanks.*
Todo arbol.	*Every tree.*

Alguno, *any, anybody, some, somebody, someone : —*

Tengo libros : ¿ tiene V. algunos ?	*I have books : have you any ?*
Alguno me ha tocado.	*Somebody has touched me.*
Algun fruto.	*Some fruit.*
Algunas cosas.	*Some things*
Creyeron algunos de ellos.	*Some of them believed.*

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* The learner must remember that *uno*, *alguno*, and *ninguno* drop the final *o* when they precede a masculine noun.

Uno, *one*, a *person* :—

Un dia.	*One day.*
Una de las hermanas.	*One of the sisters.*
No sabe uno que hacer.	*One (or a person) knows not what to do.*

Unos, *some, certain ones* :—

Unos hombres.	*Some, certain men.*
¿Dió libros á algunos de estos niños? Dió libros á unos.	*Did he give books to any of these children? He gave books to some.*

Ninguno, *nobody*, *not anyone*, *none*, *not any*, *no one* :—

Ninguno le vió.	*Nobody saw him.*
Ninguna persona.	*No person.*

Otro, *other*, *another* ; otros, *others*, *other* :—

Una cosa es prometer y otra cumplir.	*One thing it is to promise and another to perform.*
Al fin las otras mugeres vinieron.	*At length the other women came.*

Tal, *such* :—

De los tales es el estado.	*Of such is the state.*
En tal tiempo.	*In such a time.*

Ambos, entrámbos, *both* :—

Ambos me gustan bien.	*Both please me well.*
Entrámbos caen en el hoyo.	*Both fall into the pit.*

Alguien and *nadie* cannot be followed by the preposition de, *of* ; but *alguno* and *ninguno* must be used ; as—

Alguno de los muchachos.	*Some one of the boys.*
Ninguna de las hijas.	*No one of the daughters.*

Alguno is never placed after the noun, except in negative sentences, and then it has the same meaning as *ninguno* placed before the noun ; thus we can say, Yo no hallo en él ninguna causa, *or* Yo no hallo en él causa alguna, *I find no fault in him.*

Algo and *nada* may admit of an adjective joined to them, or the preposition *de* may come between ; thus we may say, algo nuevo, *or* algo de nuevo, *something new* ; nada de natural, *nothing natural.*

When by *another's* we mean the opposite of *one's own*, it is expressed in Spanish, not by *otro*, but by *ageno* (or *ajeno*); as, lo ageno, *that which is another's* ; los bienes agenos, *another's goods.*

In Spanish, two negatives serve to strengthen a negation. If in a negative sentence only one negative word is used, it must always come before the verb ; if two negative words are used, the adverb of negation must come before the verb, and the other negative word after it; thus we may say, Diego nada tiene, *or* Diego no tiene nada, *James nothing has*, or, *James not has nothing*, the meaning in English being, *James has nothing.* The former mode of expression in Spanish is generally considered more elegant.

VOCABULARY.

Aborrece, (*he*) *hates.*
Aldeano, *villager.*
Boton, *button.*
Brilla, (*it*) *shines*, (*it*) *glitters.*
Comer, *to eat.*
Cosa, *thing.*
Dara, (*he*) *will give.*
De, (*he*) *may give.*
Diez, *ten.*
Diferente, *different.*
Diga, (*he*) *may say.*
Doce, *twelve.*
Espina, *thorn.*
El Señor, *the Lord.*
Falta, *fault*, *defect.*
Hay, *there is*, *there are.*
Idioma (masc.), *idiom*, *language.*
Mal, *evil*, *ill*
Mérito, *merit.*
Obra, *work*, *deed.*
Peso, *dollar.*
Premiado, *rewarded.*
Rosa, *rose.*
Segun, *according to.*
Séa, (*he*) *may be.*
Serán, (*they*) *shall be*, or *will be.*
Sexo, *sex.*
Sin, *without.*
Tendrá, (*he*) *shall have*, or *will have.*

MODEL SENTENCES.

El juez no dijo mal de nadie, *or*, De nadie el juez dijo mal, *the judge said evil of nobody.*
Hay una casa en el camino, *there is a house on the road.*
¿No hay médico en la ciudad? *is there not a physician in the city?*

For other model sentences, the learner is referred to the examples under the indefinite pronouns.

EXERCISE 19.

Translate into English :—

1. Las tres mugeres, cada una de ellas tiene dos espejos. 2. Estos hombres serán premiados, cada cual segun sus obras. 3. Ella y todas sus hijas son robustísimas. 4. Uno y otro saben lo que es bueno. 5. ¿Hay algo de nuevo? 6. No hay nada de nuevo. 7. Los libreros no quieren nada. 8. Todo lo que Diego tiene, es mio. 9. Nadie habla mal de él. 10. El zapatero no dió los zapatos á ninguno. 11. Nada es bueno para él. 12. No sabe uno que decir. 13. ¿Tiene V. otro hermano? 14. ¿Vió alguien mi sombrero? 15. Diego halló algo en el camino. 16. Él que es rico, quienquiera que él séa, tendrá cuidados. 17. Á cualquiera que V. dé pan, Diego dará dinero. 18. ¿Dió Juan libros á algunos de estos Alemanes? 19. Sí, señor, Juan dió libros á unos. 20. ¿Tiene alguien mi espejo? 21. Nadie tiene tu espejo. 22. Unos hombres tienen dinero, otros no lo tienen. 23. Muchos aldeanos de ambos sexos vinieron á la ciudad. 24. El pintor dió un sombrero al Aleman, y un libro al Español; ambos son pobres. 25. María no habla de las faltas agenas. 26. ¿Hay rosas sin espinas? 27. No, señora, no hay rosas sin espinas? 28. ¿Hay en esa casa muchos cuartos? 29. Hay diez cuartos. 30. Juan no es Americano.

EXERCISE 20.

Translate into Spanish :—

1. Every one of the ten male servants has three roses. 2. Lucy has ten books, each one in a different^2 language^1. 3. All the female servants shall be rewarded (plur. fem.), each acording to her merits. 4. Mary gave knives to each one of them. 5. Everything which glitters is not gold. 6. Every book has leaves. 7. Peter has nothing. 8. No one of these ladies is rich. 9. One^3 knows^2 not^1 what to buy. 10. Have you (*V.*) another sister? 11. Does anyone^2 speak^1 Spanish? 12. The gentleman has two male servants; and (he) gave to the one ten dollars and to the other twelve—to each one according to his merit. 13. The shoemaker has two daughters; the name of the one is Lucy, and the

name of the other is Mary. 14. She has something to eat. 15. One of the ladies came with me. 16. My sister has everything that my father gave her. 17. To whomsoever (that) Mary may give spoons, Lucy will give forks. 18. Whatever thing (that) John may say, his houses are not handsome. 19. God hates every wicked way. 20. All this is very true. 21. Nobody has thy looking-glass. 22. Have any of those women silver forks? 23. Each one of us has some merit. 24. My nephew has not any pens. 25. Are there (any) letters for me? 26. No, sir, there are no letters for you (*V.*). 27. There are no books without leaves.

We would recommend to the learner to review carefully all the preceding lessons, especially the last four; and then, after having attentively studied the following rules, to translate the ensuing exercise.

In Spanish the definite article is to be used before all common nouns taken in a general sense, or which denote a whole class or species of things; as, La paciencia y la actividad remueven montañas, *Patience and diligence remove mountains;* Le prohiben el uso del vino, *They forbid him the use of wine;* Jamas la soberbia ni la ira podrán acordarse con la amabilidad y la mansedumbre, *Never can pride or anger agree with amiability and meekness;* Todas las cosas tienen su tiempo, *All things have their season.* Here *patience, diligence, wine, pride, anger, amiability, meekness,* and *things,* are taken in an absolute or general sense, and each requires the definite article in Spanish, though not in English, to precede it.

The definite article is not to be used in Spanish before nouns not taken in a general or determinate sense, or which do not refer to the whole class or species of things, or the whole of any object; as, Ella tiene azúcar, *She has sugar;* Juan bebe vino al almuerzo, *John drinks wine at breakfast.* Here *sugar* and *wine* are to be taken in a partitive sense, meaning *some sugar, some wine.*

VOCABULARY.

Año,	*year.*
Beneficencia,	*beneficence.*
Blanco,	*white.*
Caridad,	*charity.*
Caro,	*dear.*
Dinero,	*money.*
Dulce,	*sweet.*
El depende,	*he depends.*
Ella teme,	*she fears*
Error,	*error.*
[illegible]	[illegible]
Gratitud,	*gratitude.*
Harina,	*flour.*
Hermosura,	*beauty.*
História,	*history.*
Ignorancia,	*ignorance.*
Juan hace,	*John makes.*
Juicio,	*judgment.*
Justícia,	*justice.*
Leche, f.,	*milk.*
Maestra,	*mistress, instructress.*
Mejor,	*better.*
Mortal,	*mortal.*
Muerte, f.,	*death.*
[illegible]	[illegible]
Odioso,	*odious.*
Oro,	*gold.*
Paciente,	*patient.*
Paz,	*peace.*
Pedro prefiere,	*Peter prefers*
Plata,	*silver.*
Precioso,	*precious.*
Religion,	*religion.*
Riqueza,	*wealth, riches.*
Sociedad,	*society.*
Sueño,	*dream, sleep.*
Terrible,	*terrible.*
Tiempo,	*time.*
Útil,	*useful,*
[illegible]	[illegible]
Vida,	*life.*
Virtud,	*virtue.*
Yelo,	*ice.*

MODEL SENTENCES.

El hombre es polvo, *man is dust.*

La hermosura es despojo del tiempo, *beauty is the spoil of time.*

El hambre e sla mejor salsa, *hunger is the best sauce.*

El alma de la muger es naturalmente mas sensible que la del hombre, *the soul of woman is naturally more sensitive than that of man.*

EXERCISE 21.

Translate into English:—

1. El tiempo es mas precioso que el oro. 2. La caridad es paciente. 3. La ignorancia es madre del error. 4. La prudencia es mas preciosa que la plata. 5. Mejor es la sabiduría que la hermosura. 6. El hombre teme la muerte. 7. Los hombres son mortales. 8. El oro es precioso. 9. Juan tiene oro. 10. El dinero es útil. 11. Pedro tiene dinero. 12. Los libros son útiles. 13. Este año la harina es muy cara. 14. La manteca es muy cara. 15. La cerveza es buena. 16. La muerte es terrible. 17. La leche es blanca. 18. Juan prefiere el vicio á la virtud. 19. María no prefiere el error á la verdad. 20. Pedro prefiere las riquezas á la sabiduría. 21. El médico prefiere la cerveza al vino. 22. La prudencia y el juicio son necesarios á todo hombre. 23. La paz de la sociedad depende de (*on*) la justícia. 24. La plata es preciosa. 25. Este año la harina no es cara. 26. La religion es amable. 27. El oro es mas precioso que la plata.

EXERCISE 22.

Translate into Spanish:—

1. Time is precious. 2. Prudence is useful. 3. Vice is odious. 4. Money is useful. 5. Ice is cold. 6. Sugar is sweet. 7. Virtue is lovely. 8. Water is as good as wine. 9. Life is not a dream. 10. Wisdom is more precious than all riches. 11. Beneficence makes us amiable. 12. Man fears not life. 13. She has prudence. 14. Lucy found no books. 15. Milk is white. 16. Wine is very dear this year. 17. Gratitude is the soul of religion. 18. Wines will be good this year. 19. Forks are useful. 20. This year flour is not dear. 21. Gold is more precious than silver. 22. History is (the) instructress of life. 23. This gentleman prefers truth to error. 24. Prudence is better than money.

KEY TO EXERCISES.

Ex. 11.—1. The judge spoke to his friends. 2. My mother is hungry. 3. Her man-servant is thirsty. 4. Her daughter has three spoons. 5. Our maid-servants are culpable. 6. The book is mine. 7. The spoon is thine. 8. The hats are ours. 9. My father saw me. 10. The horses are hers. 11. The spoons are theirs. 12. The houses are mine. 13. The physician is a

ours. 15. He raised his hands. 16. She raised her eyes. 17. The man-servant has a hat in his hand. 18. My head aches. 19. My throat is sore. 20. The painter took his hat and went to the physician's house. 21. My nephew raised his head. 22. You have your money. 23. The woman has your book. 24. You wrote some letters to your friends. 25. You gave three books to your female servants. 26. The physician gave you many books. 27. The houses are yours. 28. The horses are yours. 29. Your books are good. 30. You found your money.

Ex. 12.—1. Mi amigo es rico. 2. Mi madre es pobre. 3. Mis amigos hallaron un tesoro en el camino. 4. Tu hermano vió un libro en la calle. 5. Un amigo mio hallo un sombrero. 6. El médico habló á sus amigos. 7. Mi hermano tiene hambre. 8. Su caballo es fuerte. 9. Todos mis libros son tuyos. 10. Su criada tiene sed. 11. Yo voy á su casa. 12. Nuestras criadas son garrulas. 13. Las casas son mias. 14. Las cucharas son suyas de ella. 15. Los caballos son suyos de ellos. 16. Tu casa y la mia son hermosas. 17. Tu madre y la mia tienen prudencia. 18. Tus hermanos y los mios son muy pobres. 19. Sus hermanas y las nuestras son soberbias. 20. Pedro es sobrino mio y suyo de ella. 21. El pintor es amigo mio y suyo de él 22. Una criada mia halló un sombrero en la calle. 23. Ella levanto las manos. 24. Pedro levantó la cabeza. 25. El criado tiene un sombrero en la cabeza. 26. El la tomo por la mano. 27. Ella le tomó por la mano. 28. La cabeza le duele. 29. Le duele la cabeza de Pedro. 30. Me duele la garganta. 31. El médico le tomó el sombrero, y fué a casa del pintor. 32. La muger les tomó los sombreros. 33. V. dio un libro á su padre. 34. VV. dieron dos cucharas de plata a sus criados. 35. Sus hijas de VV. son muy hermosas. 36. Los bueyes son suyos de VV. 37. El pintor le dió á V. tres sombreros. 38. Sus hijos de VV. son soberbios. 39. Sus hermanas de V. son amabilísimas. 40. V. no tiene su dinero. 41 La muger no tiene su libro. 42. V. no escribió cartas a sus amigos. 43. Tu padre es rico.

Ex. 13.—1. The man to whom the German gave the hats is very rich and ignorant. 2. The judge gave the books to an English painter in whom the physician has much confidence. 3. The women for whom Peter wrote the letters are very beautiful and rich. 4. The spoons which Mary has, and which the Frenchman found, are mine. 5. The streets of which the houses are beautiful are agreeable. 6. The houses of which the rooms are spacious are very agreeable. 7. The man who has prudence is very wise. 8. The man who has money has anxiety. 9. That which is impossible for man is possible for God. 10. That which is new is not old. 11. Peter loves that which is good. 12. She knows what to do. 13. The man does not know what to do. 14. Peter knows what is good. 15. The painter does not know what book to read. 16 She who is proud is not amiable. 17. They who love the truth are wise. 18. She who is not agreeable is unhappy. 19. The woman to whom Mary spoke is very amiable. 20. He who has gold has much care. 21. The German gave two books to the man whom John saw.

Ex. 14.—1. El médico es quien escribio la carta que V. vió. 2. Las Españolas son quienes dieron los libros á Pedro. 3. Las mugeres á quienes el juez escribio las cartas son muy pobres e ignorantes. 4. La Francesa a quien Pedro ama es muy hermosa. 5. La Alemana á quien V. vio, me escribió muchas cartas. 6. El caballo que Juan vió, y del cual Pedro habló, es fuerte. 7. El hombre cuyo nombre es Juan vinó a mi casa. 8. La muger cuyo nombre es Maria me dió tres libros. 9 Juan dió tres cucharas de plata á una muger cuyo nombre es María. 10. El pintor y el impresor vinieron á Madrid, en cuya ciudad el pintor halló un tesoro. 11. La muger que es soberbia é ignorante e desgraciada. 12. Los hombres que tienen dinero tienen cuidados. 13. Lo que es posible para Pedro es posible para Juan. 14. El Frances tiene el tesoro que el médico hallo en la calle de la ciudad. 15. María sabe lo que es bueno. 16. El pintor no sabe que hacer. 17. La hermana del medico no sabe que comprar. 18. Mis hermanos no saben cuales libros comprar. 19. Los Alemanes no saben cual sombrero tomar. 20. Ella no sabe cual cuchara tomar. 21. Él que tiene sabiduría tiene prudéncia. 22. Él que tiene prudencia es sabio. 23. Mi padre tiene tesoro que su criado halló en la ciudad. 24. Los que nos dieron los libros son amigos nuestros. 25. La ciudad en que Pedro halló los libros es grande y hermosa. 26. El pintor fué á Madrid, en cuya ciudad las calles son agradables y las casas hermosas.

COMPARATIVE ANATOMY. —VI.

[*Continued from p.* 60.]

VERMES (WORMS) (*continued*).

THE representative of one of the families of sea-worms is the common sea-mouse (*Aphrodite*). It is much broader and shorter than most worms, being of an oval form. That which is most attractive about this otherwise inert and uninteresting animal is the splendid play of colours which glances from the thickly set bristles which clothe its sides. The bristles are from their shape not only locomotive organs but means of defence; for many of them are found, under the microscope, to be small harpoons, furnished with many barbs. These, like the oar-bristles of other families, are capable of being withdrawn into pits made by the inversion of the papillæ on which they are set. Lest the harpoons should wound the skin when withdrawn, each is furnished with a sheath consisting of two pieces, which are made into a split tube holding the retracted weapon. The common sea-mouse has two stalked eyes and three tentacles on its head. One great peculiarity of its structure is that its back is covered in with a coating of felt composed of tangled and matted hairs. This felt covering is not continuous, but consists of pairs of plates attached to certain segments of the body, the hind edges of the front plates overlapping the front edges of those which come behind. These plates are moved up and down by muscles, which are capable of erecting and depressing them. Since these plates are not attached to all the segments, but are only appendages to some of them, while the intermediate ones are furnished with gills, which lie under the felt, the reader will observe that there will be a chamber between the felt-like roof and the proper dorsal wall of the animal. In this chamber the delicate gills of the animal are protected from being bruised, and fresh filtered water is supplied to them in the following manner. When the plates are slowly erected, or removed from the back, water flows through their porous substance, and when they are drawn rapidly down, the water is forced backward along the whole length of the back, laving the gill fringes, and passing out behind.

The animals we have hitherto described are grouped together under the title Errantia, or wandering animals, because they are capable of locomotion; but other families occupy protective tubes, made of particles of sand glued together, or of compact carbonate of lime. In accordance with this mode of life, all the feelers and respiratory organs have to be crowded together around the head, which alone projects from the tube.

The common earth-worm has no external gills, and instead of close-set bundles of setæ or bristles which act as oars, it has only eight thorn-like locomotive organs on the sides of each segment. These can be protruded or retracted, and the animal makes use of them as holders to prevent one part of the body being dragged back while the other is drawn up to it by muscular contraction.

The leech is the type of another large order. Its skin is perfectly smooth; and, being deprived of the means of progression enjoyed by its neighbours, it is compensated by having at each end of its body a sucking disc, by the aid of which it moves about. In it the body cavity is obliterated, for though the main tube of the stomach is small as compared with the tube of the body, and septa unite them as in other annulata, yet this tube sends forth lateral pockets, which swell outward till they come close to the skin.

The use of the leech was so widely recognised that the demand for these animals was very large, and a number used to be imported into this country annually. It is difficult to conceive of an animal better suited to the surgeon's purpose. It makes a puncture with its three compound teeth shaped like the letter Y; and this is of such a nature that while it admits of the free flow of the blood while suction is going on, yet but little drains away afterwards. Again, the creature always fills itself to repletion, though its stomach is, of course, of limited capacity, so that a certain number of leeches applied indicates a definite amount of blood abstracted.

The class Annulata may be divided into orders thus:—

1. *Suctoria*, of which the leech is a type.
2. *Oligochæta* (with few bristles), of which the earth-worm is a type.
3. *Polychæta* (with many bristles).
    - α. *Tubicolæ*, of which the serpula is a type.
    - β. *Errantia*, of which the lob-worm and Nereis are types.

ROTATORIA.

We may notice at this stage a class of animals whose relations to other classes are difficult to express. As we have before stated that it is quite impossible to place the whole array of animals in a single line according to their grades of structure, the reader will not be surprised that we have to break off in the midst of the description of a definite and well-sustained series of animals to treat of a class which cannot well be inserted into that series. The class referred to is called Rotatoria. The animals which compose it are decidedly inferior in complexity of structure to the animals we shall have to describe as coming in the next order to the Annulates, and also in many respects inferior to the Annulates themselves, and yet they seem to lead up to a class of animals called Crustacea, which are as decidedly of a higher type than the worms.

The Rotatoria were first classed with the Infusoria by Ehrenberg. This classification was not to be wondered at, as all the rotary animals are microscopic, and they are often found in infusions of vegetable or animal substances in water. Their outward appearance is also not unlike that of the higher Protozoa, and they move about by the same means as many of these do—that is, by means of the vibrations of closely set, fine, short, delicate hairs, called cilia. These cilia are so named from the Latin *cilium*, "an eye-lash." The cilia in the Rotatoria, instead of being scattered all over the surface of the animal, as in Paramecium (a protozoon), or in the Turbellaria, are confined to flat, convex lobes, situated round or near the mouth, whose edges they fringe. When the animal fixes itself, the motion of these lashes brings food to its mouth by causing currents of water to pass towards it; and when it relaxes its hold, then the same motion causes it to progress through the water much in the same way as a screw-steamer is propelled. Some of these animals have the lobes all united into one circular disc, and as the motion of the cilia is so ordered as to cause the appearance of a number of successive waves, following one another round and round the circle, it was once thought that the disc was a kind of cogged wheel whirling rapidly about a fixed axle. Hence the name Rotifera, or wheel-bearing animals, was given to them. If this had been the right explanation of the motion, it would have furnished an instance of a locomotive apparatus met with nowhere else in the whole animal kingdom. A little reflection concerning this contrivance led some naturalists to doubt whether it really existed. Of course it is essential to the mechanical device which we call a wheel that it should be entirely disconnected with the axle upon which it plays, otherwise it could not revolve; and yet it is essential to all animal structures, especially to these employed in locomotive actions, that there should be an organic communication between them and the organs of nutrition, by means of which liquids can be sent to supply the waste caused by vital actions. This liquid must also be sent in such a way as not to be lost or wasted in the transit. It would seem, then, that the mechanism of the wheel is inconsistent with animal organisation. These considerations led to a fresh study of the so-called wheel-animalcules. It is almost needless to remark that the separate cilia were too small for their motions to be distinctly traced, otherwise the mistake could never have occurred. It is now recognised that the successive action of the cilia gives rise to an optical illusion, by which the appearance of rotation is maintained, while the organ on which the cilia is situated remains stationary. This view is supported by observing the same motion in those nearly-allied creatures, members of the same class, whose discs are not circular but divided into lobes. In these species it can be seen that the lobes do not participate in the revolutions. The way in which this optical illusion is effected will be best seen by reference to the illustration (Fig. 26, VI.). From this it may be seen that if the cilia are deflected from the perpendicular only in one direction, and that a number of these act together, so as to cross one another while the down-stroke is given, it will give rise to a number of dark points where the crossing occurs, which points, by the successive action of each cilium in the series, will seem to pass rapidly round the disc, while, since each returns to its erect position separately and slowly, the eye cannot trace their motion. This method of explanation is rendered more probable by the fact that these aquatic creatures are usually examined under the microscope by means of transmitted light, and hence anything which cuts off the rays of light at a particular point will catch the eye and be followed by it.

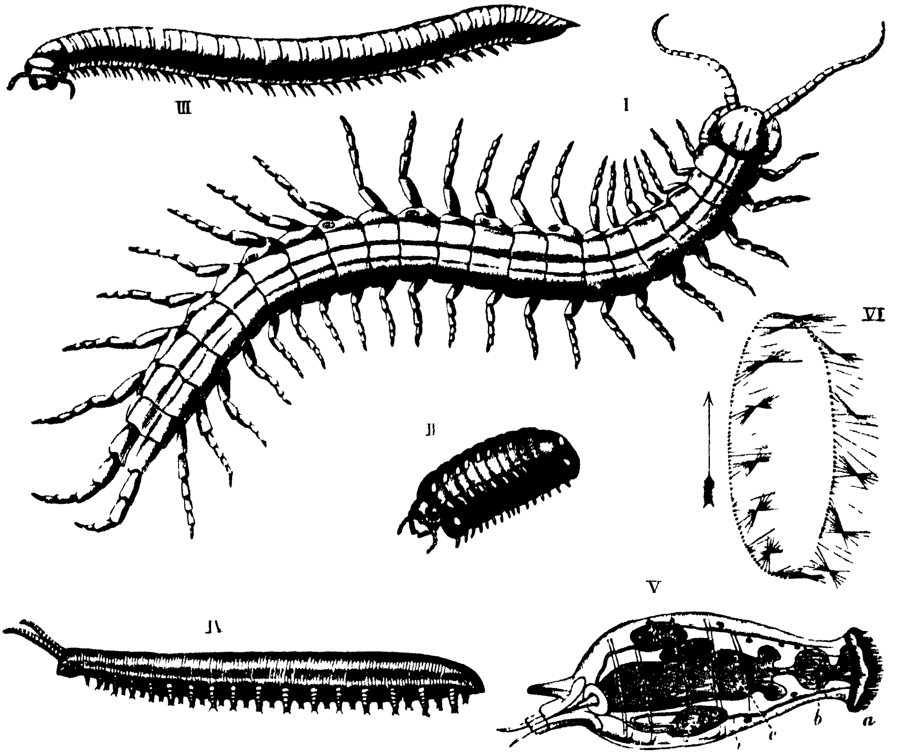

Fig. 26.—I. Scolopendra Morsitans. II Glomeris. III. Julus. IV. Peripatus Capensis. V. Notomata Centrura. VI. Scheme showing the Nature of the Rotary Illusion.

Refs. to letters in Fig. V.—*a*, ciliated disc; *b*, gizzard, *c*, stomach; *d*, water-vascular system; *e*, ovum; *f*, forceps.

These cilia are found so very generally throughout the range of the animal series—they are placed on such different parts of animals, and applied to such different purposes—that it is as well to give some little time to the consideration of them. We have already had occasion to mention them as covering the body of some Infusoria, and being applied to locomotion. They are also found on the inner (as well as the outer) wall of the Cœlenterata, and there cause a circulation of the fluid in the stomach. They are set on the combs of the Ctenophora, and in bands on the larvæ of the Echinodermata, and in these situations they are swimming organs. We mentioned them also as set on the tufts of vessels called gills in the Annulates, and we shall find them again on the plate-like gills of Lamellibranchiata, and in these positions they cause a change in the external water, and so subserve the function of respiration. In the human subject they cover the membrane of the nasal chambers, the trachea, and the tubes leading to the lungs, and are continually employed to bring up the mucus which would else choke the passages. In all these cases, and in a thousand more which might be mentioned, their action, though applied to different purposes, is essentially the same. Their motion always creates an appearance of waves moving along in one definite direction, and never returning. It is very easy to attribute motion to ciliary action, and, of course, if the action be capable of driving liquid over the surface, it is also able to move the surface upon which the cilia are set, and the animal with it when that animal floats in liquid; but it is not an easy thing to explain the method of this action. When we say that the circulation in sponges is maintained by the ciliated chambers, the cilia of which whip the water in one direction, we are repeating what a multitude of writers have said before us, but we by no means explain the motion. If a switch be passed violently backwards and forwards through air or water, it creates a commotion, but it has no tendency to move the air or water, or the hand which holds it, in any definite direction. How, then, do these minute switches effect their purpose? Why does not the effect of the motion in one direction exactly counterbalance the effect of the motion in the other? The writer conceives the following to be the explanation, for which the reader will be in some measure prepared by the remarks already made on the ciliary action in the Rotatoria. Suppose we conceive of a number of upright rods set on a membrane in a line corresponding to the line of the resulting waves, and moving in a direction at right angles to this, or in the direction of the waves caused by them. If one cilium or rod act alone, being rapidly brought down, the liquid will be thrown off from its sides to the right and left, the more obliquely in proportion to the rapidity of its motion. It will make its way by splitting the fluid, which, being thrown off laterally, will finally unite behind it. But suppose the rods on each side of this single rod are in motion in a parallel direction at the same time, then it comes in contact, not with stagnant water, but with the conjoined stream thrown off by these, which furnishes a greater resistance than if it acted alone. The water thus impinging on the central rod will be prevented from readily uniting behind the other two; so that the vacuum will be filled up, not by the water which has passed through the interstices of the line of rods, but by fresh water which flows in from behind. In other words, when the cilium acts alone, the resistance it meets with is in proportion to the section of the rod itself; but when it acts with its neighbours, the resistance is little short of being proportional, not to the section of the several rods, but to them and the whole space which lies between them. This speculation seems to be confirmed by experiment; for if a sheet of wire gauze be passed rapidly enough through the water, it is resisted with almost as great force as if it were not perforated. When fine sand is thrown out of a balloon in rapid descent, it appears to fly violently upward, although the resistance opposed by the atmosphere to each particle in relation to its weight is small as compared to that offered by the balloon in proportion to its weight. According to this theory, then, a number of cilia are depressed in concert and so create a wave, and only rise slowly and separately after the wave has passed on, and so assume an erect posture ready to propel a fresh wave at a considerable distance from the one which preceded it. This conforms well with the appearance created by the cilia both when they are used to pass liquid over their surface, and when they are employed as locomotive organs. This partial explanation leaves entirely untouched the problem of how the cilia themselves are set in motion. The cilia of the Rotatoria seem to differ from those of most other animals in being under the control of the will of the animal.

When a better appreciation of the action of the ciliary fringes of these animals was attained, the name Rotifera (*Wheel-bearing animalcules*) was changed into Rotatoria, or rotary animals; other details of their structure show them to be much more highly organised than the simple Protozoa, which inhabit the same waters, feed upon similar food, and are moved by a like agency. The females have a definite alimentary canal, complete from end to end, and in some this canal is of very complex structure. The animals are transparent, and admit of the examination of their internal organs while alive; and to aid in this examination, Ehrenberg placed some indigo, in an extremely fine state of division, into the water where they were. He had the satisfaction of seeing the little opaque particles, moved by the ciliary currents, swallowed, and pass through the whole length of the alimentary canal, and thus make it more distinct. Immediately below the gullet, in some (as in the Notommata of our illustration), is an enlarged chamber, furnished with a dentary apparatus, which from its internal position is called a gizzard. In the Notommata the dental apparatus consists of two teeth, one situated on each side of a central fixed tooth, and playing upon it as the hammers of two blacksmiths fall on an anvil. Below the gizzard is a globular or elongated stomach, which is succeeded in some species by a narrow intestine, but in the one before us ends at once in a cloaca, from which the exit is at the forked tail end of the animal. Round glands, supposed to have a digestive function, empty themselves into the fore-part of the stomach. From the cloaca two winding ducts pass up, one on each side of these, and represent the water-vascular system. On these ducts, fastened by short stalks, are some little button-like organs, which are kept in rapid vibration, and aid in the excretory function. The outer wall of the animal is often of an inflexible or slightly flexible material, which may be called a shell. This preserves the flask-shaped body in its ordinary dimensions, and gives origin to muscles which run to, and can retract into the shell, the disc at one end of the body, and also the forceps by which the animal attaches itself at the other end. The hind part of these creatures is usually divided into rings, which, together with the structure of the stomach, show an approach to the Crustacean type. Of all the Rotifers *Pedalion* is the closest to the Crustacea.

GERMAN.—XXXVIII.

[*Continued from p. 55.*]

PARADIGMS OF IRREGULAR VERBS (*continued*).

Sollen, *to be obliged.*

Ind. *Pres.* Ich ſoll, du ſollſt, er ſoll; wir ſollen, ihr ſollt, ſie ſollen.—*Past.* Ich ſollte, du ſollteſt, er ſollte, wir ſollten, ihr ſolltet, ſie ſollten.—*Pres. Perf.* Ich habe geſollt, wir haben geſollt.—*Plup.* Ich hatte geſollt, wir hatten geſollt.—*Fut. Imp.* Ich werde ſollen; wir werden ſollen.—*Fut. Perf.* Ich werde geſollt haben; wir werden geſollt haben.

Sub. *Pres.* Ich ſolle, du ſolleſt, er ſolle; wir ſollen, ihr ſollet, ſie ſollen.—*Past.* Ich ſollte, du ſollteſt, er ſollte; wir ſollten, ihr ſolltet, ſie ſollten.—*Pres. Perf.* Ich habe geſollt; wir haben geſollt.—*Plup.* Ich hätte geſollt; wir hätten geſollt.—*Fut. Imp.* Ich werde ſollen; wir werden ſollen.—*Fut. Perf.* Ich werde geſollt haben; wir werden geſollt haben.

Cond. *Fut. Imp.* Ich würde ſollen; wir würden ſollen.—*Fut. Perf.* Ich würde geſollt haben; wir würden geſollt haben.

Inf. *Pres.* Sollen, to be obliged.—*Perf.* Geſollt haben, to have been obliged.

Part. *Pres.* Sollend, being obliged.—*Past.* Geſollt, obliged.

Remarks on Sollen.—The primary and prevalent use of ſollen is to indicate *obligation* or *command*. What particular word or phrase shall be employed to translate it, in any given case, must be determined by circumstances. The following examples will be sufficient to show this:—

Du ſollſt das thun, thou *art to* (*i.e.*, art *commanded* to) do that.

Er ſoll gehen, he *is to* (*i.e.*, is *bidden* to) go.

Soll ich es haben? *am I to* have it?

Die Flotte ſoll geſchlagen worden ſein, the fleet *is said* (or *reported*) *to* be beaten.

Sie ſollen ihn nicht beleidigt haben, you are *supposed* (or *admitted*) not to have offended him.

Was ſoll der Hut? what *means* the hat?

Wenn er kommen ſollte, ſo will ich es ihm ſagen, if he *should* come, I will tell him so.

So with an infinitive understood: Was ſoll ich? what *am I to* (*do*)? was ſoll das? what *signifies* that? (*i.e.*, supplying ſein, *what is that to be?*)

Er weiß nicht, was er thun ſoll, he does not know what to do.

Wiſſen, *to know.*

Ind. *Pres.* Ich weiß, du weißt, er weiß, wir wiſſen, ihr wißt, ſie wiſſen.—*Past.* Ich wußte, du wußteſt, er wußte, wir wußten, ihr wußtet, ſie wußten.—*Pres. Perf.* Ich habe gewußt, wir haben gewußt.—*Plup.* Ich hatte gewußt; wir hatten gewußt.—*Fut. Imp.* Ich werde wiſſen; wir werden wiſſen.—*Fut. Perf.* Ich werde gewußt haben; wir werden gewußt haben.

Sub. *Pres.* Ich wiſſe, du wiſſeſt, er wiſſe; wir wiſſen, ihr wiſſet, ſie wiſſen.—*Past.* Ich wüßte, du wüßteſt, er wüßte; wir wüßten, ihr wüßtet, ſie wüßten.—*Pres. Perf.* Ich habe gewußt; wir haben gewußt.—*Plup.* Ich hätte gewußt; wir hätten gewußt.—*Fut. Imp.* Ich werde wiſſen; wir werden wiſſen.—*Fut. Perf.* Ich werde gewußt haben; wir werden gewußt haben.

Cond. *Fut. Imp.* Ich würde wiſſen; wir würden wiſſen.—*Fut. Perf.* Ich würde gewußt haben; wir würden gewußt haben.

Imp. *Pres.* Wiſſe (du), wiſſe er; wiſſen wir, wiſſet (ihr), wiſſen ſie.

Inf. *Pres.* Wiſſen, to know.—*Perf.* Gewußt haben, to have known.

Part. *Pres.* Wiſſend, knowing.—*Past.* Gewußt, known.

Wollen, *to be willing.*

Ind. *Pres.* Ich will, du willſt, er will; wir wollen, ihr wollt, ſie wollen.—*Past.* Ich wollte, du wollteſt, er wollte; wir wollten, ihr wolltet, ſie wollten.—*Pres. Perf.* Ich habe gewollt; wir haben gewollt.—*Plup.* Ich hatte gewollt; wir hatten gewollt.—*Fut. Imp.* Ich werde wollen; wir werden wollen.—*Fut. Perf.* Ich werde gewollt haben; wir werden gewollt haben.

SUB. *Pres.* Ich wolle, du wolleſt, er wolle; wir wollen, ihr wollet, ſie wollen.—*Past.* Ich wollte, du wollteſt, er wollte; wir wollten, ihr wolltet, ſie wollten.—*Pres. Perf.* Ich habe gewollt; wir haben gewollt.—*Plup.* Ich hätte gewollt; wir hätten gewollt.—*Fut. Imp.* Ich werde wollen; wir werden wollen.—*Fut. Perf.* Ich werde gewollt haben; wir werden gewollt haben.

COND. *Fut. Imp.* Ich würde wollen; wir würden wollen. — *Fut. Perf.* Ich würde gewollt haben; wir würden gewollt haben.

IMP. *Pres.* Wolle, wollet.

INF. *Pres.* Wollen, to be willing.—*Perf.* Gewollt haben, to have been willing.

PART. *Pres.* Wollend, willing.—*Past.* Gewollt, willed.

REMARKS ON Wollen.—Wollen implies future *purpose*, thus:—Ich will gehen, I will (to) go, *i.e.*, my *purpose* is to go. The expression of mere futurity would be, Ich werde gehen. Kindred to this is another signification of wollen, as:—Er will dich geſehen haben, he wills to have seen you; that is, he *will have it* (or *affirms*) that he saw you.

EXAMPLES FURTHER ILLUSTRATING THE USES OF THE PRECEDING VERBS.

Ich darf es thun.	I am allowed to do it.
Es dürfte wohl geſchehen.	It might easily happen.
Du darfſt es nur fordern.	You need only ask for it.
Er kann weder leſen noch ſchreiben.	He can neither read nor write.
Ich kann mich irren.	I may be mistaken.
Ich konnte ihn nicht verſtehen.	I could not understand him.
Können Sie heute zu mir kommen?	Can you come to me today?
Ich mag das nicht.	I do not like that.
Ich möchte gern wiſſen wieviel Uhr es iſt.	I should like to know what o'clock it is.
Ich möchte wohl etwas davon haben.	I should like to have some of it.
Es mag ſein.	It may be.
Ich möchte lieber.	I had rather; I would rather.
Möge er lange leben!	Long may he live!
Ich muß es thun.	I must do it.
Er müßte ſich ſeines Betragens ſchämen.	He would be ashamed of his conduct.
Mußte es nicht ſo kommen?	Could it happen otherwise?
Wenn ich ſterben müßte, würde ich es nicht thun.	If I had to die, I would not do it.
Ich wollte gerne gehen.	I would willingly (*i.e.*, would like to) go.
Ich will zu Fuße gehen.	I will go on foot.
Ich wollte, daß wir gehen ſollten.	I was for our going.
Sie ſollen ſchreiben.	You are to write.
Was ſoll das heißen?	What does that mean?
Es ſoll ſich zugetragen haben.	It is said to have happened.
Der König ſoll angekommen ſein.	The king is said to have arrived.
Wenn er morgen ſterben ſollte.	If he should die to-morrow.
Wenn das ſo ſein ſollte.	If that should be so.

PASSIVE VERBS.

The passive voice is formed by adding to the auxiliary werden, *to become*, through all its moods and tenses, the past participle of the main verb; thus—

	INDIC. ACTIVE.	INDIC. PASSIVE.
Pres.	Ich lobe, I praise.	Ich werde gelobt, I am praised.
Past.	Ich lobte, I praised.	Ich wurde gelobt, I was praised.
Pres. Perf.	Ich habe gelobt, I have praised.	Ich bin gelobt worden, I have been praised.
Plup.	Ich hatte gelobt, I had praised.	Ich war gelobt worden, I had been praised.
Fut. Imp.	Ich werde loben, I shall praise.	Ich werde gelobt werden, I shall be praised.
Fut. Perf.	Ich werde gelobt haben, I shall have praised.	Ich werde gelobt worden ſein, I shall have been praised; etc.

It will be noted, that wherever the past participle of the main verb (as gelobt above) is joined with the participle of the auxiliary, the latter is written worden, not geworden, whereby an offensive repetition of the syllable ge- is avoided. Sometimes worden is altogether omitted in the past tenses.

The German, by confining werden with the past participle to the expression of *passivity*, and using ſein when the participle is to be taken as a mere *adjective*, has a manifest advantage over the English passive. Thus, if we wish to say in German, *he is feared*, it will be, Er wird gefürchtet. If the intention, however, be merely to mark the state or character of the person as one who is feared—that is, whose character or conduct inspires fear generally—the German will be, Er iſt gefurchtet, he is (a) feared (man). The form of expression in English, it will be observed, is the same for *both* ideas—"he *is* feared."

The Germans, however, employ the passive form far less frequently than the English. They prefer other methods, thus:—Man ſagt, one says (*i.e., it is said*); Der Schlüſſel hat ſich gefunden, the key has been found.

PARADIGM OF A PASSIVE VERB.

Gelobt werden, *to be praised.*

INDICATIVE MOOD.

	PRESENT.		PAST.
S.	Ich werde gelobt, I am praised.	*S.*	Ich wurde gelobt, I was praised.
	Du wirſt gelobt.		Du wurdeſt gelobt.
	Er wird gelobt.		Er wurde gelobt.
P.	Wir werden gelobt.	*P.*	Wir wurden gelobt.
	Ihr werdet gelobt.		Ihr wurdet gelobt.
	Sie werden gelobt.		Sie wurden gelobt.

	PRESENT PERFECT.		PLUPERFECT.
S.	Ich bin gelobt worden, I have been praised.	*S.*	Ich war gelobt worden, I had been praised.
	Du biſt gelobt worden.		Du warſt gelobt worden.
	Er iſt gelobt worden.		Er war gelobt worden.
P.	Wir ſind gelobt worden.	*P.*	Wir waren gelobt worden.
	Ihr ſeid gelobt worden.		Ihr waret gelobt worden.
	Sie ſind gelobt worden.		Sie waren gelobt worden.

	FUTURE IMPERFECT.		FUTURE PERFECT.
S.	Ich werde gelobt werden, I shall be praised.	*S.*	Ich werde gelobt worden ſein, I shall have been praised.
	Du wirſt gelobt werden.		Du wirſt gelobt worden ſein.
	Er wird gelobt werden.		Er wird gelobt worden ſein.
P.	Wir werden gelobt werden.	*P.*	Wir werden gelobt worden ſein.
	Ihr werdet gelobt werden.		Ihr werdet gelobt worden ſein.
	Sie werden gelobt werden.		Sie werden gelobt worden ſein.

SUBJUNCTIVE MOOD.

	PRESENT.		PAST.
S.	Ich werde gelobt, I may be praised.	*S.*	Ich würde gelobt, I might be praised.
	Du werdeſt gelobt.		Du würdeſt gelobt.
	Er werde gelobt.		Er würde gelobt.
P.	Wir werden gelobt.	*P.*	Wir würden gelobt.
	Ihr werdet gelobt.		Ihr würdet gelobt.
	Sie werden gelobt.		Sie würden gelobt.

	PRESENT PERFECT.		PLUPERFECT.
S.	Ich ſei gelobt worden, I may have been praised.	*S.*	Ich wäre gelobt worden, I might have been praised.
	Du ſeieſt gelobt worden.		Du wäreſt gelobt worden.
	Er ſei gelobt worden.		Er wäre gelobt worden.
P.	Wir ſein gelobt worden.	*P.*	Wir wären gelobt worden.
	Ihr ſeiet gelobt worden.		Ihr wäret gelobt worden.
	Sie ſeien gelobt worden.		Sie wären gelobt worden.

	FUTURE IMPERFECT.		FUTURE PERFECT.
S.	Ich werde gelobt werden, (if) I shall be praised.	*S.*	Ich werde gelobt worden ſein, (if) I shall have been praised.
	Du werdeſt gelobt werden.		Du werdeſt gelobt worden ſein.
	Er werde gelobt werden.		Er werde gelobt worden ſein.
P.	Wir werden gelobt werden.	*P.*	Wir werden gelobt worden ſein.
	Ihr werdet gelobt werden.		Ihr werdet gelobt worden ſein.
	Sie werden gelobt werden.		Sie werden gelobt worden ſein.

CONDITIONAL MOOD.

	FUTURE IMPERFECT.		FUTURE PERFECT.
S.	Ich würde gelobt werden, I should be praised.	*S.*	Ich würde gelobt worden ſein, I should have been praised.
	Du würdeſt gelobt werden.		Du würdeſt gelobt worden ſein.
	Er würde gelobt werden.		Er würde gelobt worden ſein.
P.	Wir würden gelobt werden.	*P.*	Wir würden gelobt worden ſein.
	Ihr würdet gelobt werden		Ihr würdet gelobt worden ſein.
	Sie würden gelobt werden.		Sie würden gelobt worden ſein.

IMPERATIVE MOOD.

PRESENT.

Sing.	Werde (du) gelobt, be (thou) praised.
	Werde er gelobt, let him be praised.
Plur.	Werden wir gelobt, let us be praised.
	Werdet (ihr) gelobt, be ye praised.
	Werden ſie gelobt, let them be praised.

INFINITIVE MOOD.

PRESENT.	Gelobt werden, to be praised.
PERFECT.	Gelobt worden ſein, to have been praised.
FUTURE.	Werden gelobt werden, to be about to be praised.

PARTICIPLE.

PAST. Gelobt, praised.

REFLECTIVE VERBS.

A verb is said to be *reflective* when it represents the subject as acting upon itself. We frequently use the form in English—He *deports* himself well; he *bethought* himself; they *betook* themselves to the woods—where the subject and the object, in each case, being identical, the verb is made reflective. It is manifest that any active transitive verb may thus become a reflective verb.

Strictly speaking, however, those only are accounted reflectives that cannot otherwise be used. The number of these in German is much larger than in English. Some of them require the reciprocal pronoun to be in the dative, but most of them govern the accusative. Thus (with the dative), Ich bilde mir nicht ein, I do not imagine; (with the accusative), Ich ſchäme mich, I am ashamed. Further examples are the following:—

WITH THE DATIVE.	WITH THE ACCUSATIVE.
Sich anmaßen, to presume, usurp.	Sich anſchicken, to prepare.
Sich ausbedingen, to make a condition.	Sich äußern, to intimate.
Sich einbilden, to imagine.	Sich bedanken, to thank.
Sich getrauen, to dare.	Sich bedenken, to pause, to think.
Sich ſchmeicheln, to flatter oneself.	Sich begeben, to repair to, to happen.
Sich vornehmen, to propose to oneself.	Sich behelfen, to put up with, to make do.
Sich vorſtellen, to represent to oneself.	Sich freuen, to rejoice.
Sich widerſprechen, to contradict oneself.	Sich widerſetzen, to resist.

Since the action of these verbs is confined to the agent, they are rightly regarded as *intransitives;* for the verb and the pronoun under its government are to be taken *together* as a single expression for intransitive action, thus:—Ich freue mich, I rejoice *myself* (that is, *I rejoice* or *delight in*).

In like manner reflectives often become the equivalents of *passives*, as:—Der Schlüſſel hat ſich gefunden, the key has *found itself* (that is, the key *is found*, or *has been found*), etc.

In some instances a verb is found to have, both in the simple and the reflective form, the same signification, as:—Irren, and Sich irren, to err, to be mistaken.

It is worthy of remark also that some transitives, upon passing into the reflective form, undergo some change of signification. Thus, from berufen, to call, comes ſich berufen, *to appeal to.* It is generally easy, however, in these cases, to account for such changes. The following are additional examples:—

Bedenken, to think upon.	Sich bedenken, to pause, to think.
Beſcheiden, to assign.	Sich beſcheiden, to be contented with.
Finden, to find.	Sich finden (in etwas), to accommodate oneself to a thing.
Fürchten, to fear.	Sich fürchten, to be afraid of.
Hüten, to guard.	Sich hüten, to beware.
Machen, to make.	Sich machen (an etwas), to set about a thing.
Stellen, to place.	Sich ſtellen, to feign, pretend.
Verantworten, to answer for.	Sich verantworten, to defend oneself.
Vergehen, to pass away.	Sich vergehen, to commit a fault.
Verlaſſen, to leave.	Sich verlaſſen, to rely upon.

PARADIGM OF A REFLECTIVE VERB.

Sich freuen, *to rejoice.*

INDICATIVE MOOD.

	PRESENT.		PAST.
S.	Ich freue mich, I rejoice.	*S.*	Ich freute mich, I rejoiced.
	Du freuſt dich.		Du freuteſt dich.
	Er freut ſich.		Er freute ſich.
P.	Wir freuen uns.	*P.*	Wir freuten uns.
	Ihr freut euch.		Ihr freutet euch.
	Sie freuen ſich.		Sie freuten ſich.
	PRESENT PERFECT.		**PLUPERFECT.**
S.	Ich habe mich gefreut, I have rejoiced.	*S.*	Ich hatte mich gefreut, I had rejoiced.
	Du haſt dich gefreut.		Du hatteſt dich gefreut.
	Er hat ſich gefreut.		Er hatte ſich gefreut.
P.	Wir haben uns gefreut.	*P.*	Wir hatten uns gefreut.
	Ihr habt euch gefreut.		Ihr hattet euch gefreut.
	Sie haben ſich gefreut.		Sie hatten ſich gefreut.
	FUTURE IMPERFECT.		**FUTURE PERFECT.**
S.	Ich werde mich freuen, I shall rejoice.	*S.*	Ich werde mich gefreut haben, I shall have rejoiced.
	Du wirſt dich freuen.		Du wirſt dich gefreut haben.
	Er wird ſich freuen.		Er wird ſich gefreut haben.
P.	Wir werden uns freuen	*P.*	Wir werden uns gefreut haben.
	Ihr werdet euch freuen.		Ihr werdet euch gefreut haben.
	Sie werden ſich freuen.		Sie werden ſich gefreut haben.

KEY TO TRANSLATION FROM GERMAN (p. 55).

BYRON AND POLIDORI.

As Lord Byron himself relates, the following conversation took place between him and Polidori, a very vain Italian physician, during a journey on the Rhine. "What can you do, then, which I cannot?" asked the physician. "Do you urge me?" answered the poet, "then I will tell you; I think there are three such things" Polidori insisted that he should name them, and Lord Byron said: "I can swim across this stream; I can snuff out a light from a distance of twenty paces with a pistol shot; and I have written a poem, of which 14,000 copies will be sold in a day."

LIGHT.—I.

THE ORIGIN AND EFFECTS OF LIGHT.

To the general observer light is something impalpable which silently and rapidly suffuses itself over the face of the earth with the rise of the sun, and as silently and gradually vanishes when it sets. It is created during combustion and in the manifestation of many electrical phenomena; it moves through the space which separates star from star with incredible rapidity, being the bond of union and of

communication between the world-units of the universe, and it has power even to transmit itself through solid bodies. What is it? How does it behave? and how may it be produced? are some of the questions we shall try to answer.

Fig. 1.

HOW LIGHT IS PRODUCED.

Light may be produced in a variety of ways. We are in a dark room, so dark that nothing whatever is visible. The readiest way of getting a light is to strike a match. Friction causes the phosphorus on the match to burn, and this in its turn ignites the wood. The source of light here is comparable to that of a candle, a gas jet, or a paraffin oil lamp, for in each case we have flame—the active chemical change which we term combustion.

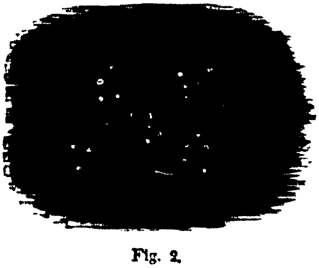

Fig. 2.

Next take two pieces of loaf sugar and strike them together in this dark room. A faint glow of light is perceptible, not unlike in appearance the glowing track left by a match when one attempts to light it by friction—this faint track being traces of phosphorus which is undergoing slow combustion. The light emitted by the sugar on knocking the pieces together looks like this phosphoric light, and the phenomenon is termed phosphorescence, although the cause of it is not a chemical change like that which is happening in the case of the slowly burning phosphorus.

Another example of phosphorescence may be seen in the following manner. Take some Derbyshire spar, what the chemist calls fluoride of calcium; powder it and place it on a hot plate of iron, as, *e.g.*, a heated shovel, and take it into the dark room—it gives out light. Examples of phosphorescence, or the production of a faint light, are also yielded by vegetable and animal bodies. Thus, decaying wood is sometimes seen to shine in the dark, fish in the pantry yields a phosphorescent light, while glow-worms (Fig. 1) and fire-flies—where they abound—are conspicuous objects in the night, and even the sea may become faintly luminous owing to the presence of a minute organism termed *Noctiluca miliaris* (Fig. 2).

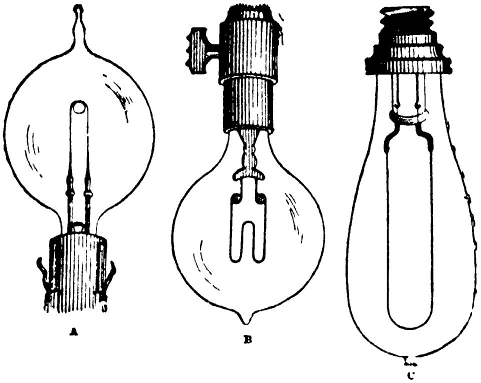

Fig. 3.—A, Edison Lamp; B, Maxim Lamp; C, Swan Lamp.

In the aurora borealis we have light produced by an electric discharge in the higher regions of the atmosphere, and the lightning flash is a powerful and concentrated discharge of electricity.

Now let us suppose that wires are conducted into our dark room from a dynamo, or a machine for generating electricity, and that these wires are connected to an incandescent or "glow" lamp (Fig. 3). The dynamo is set going, and the electric current is sent through the lamp. The filament of carbon inside the glass first becomes red like red-hot iron, and very shortly acquires a white heat, and in this incandescent condition illuminates the room. A current of electricity sent through a piece of platinum in the same way raises it to incandescence and makes it a source of light.

Take a piece of clean platinum foil or a spiral of platinum wire, and hold it in the non-luminous Bunsen flame while it becomes red-hot (Fig. 4); now cut off the supply of gas. The platinum being momentarily without the impact of flame on it, becomes non-luminous; but if the mixture of air and gas be allowed to impinge on it while it is still hot, the cold gas makes it red-hot again, singular as this may seem, owing to what is known as surface condensation. Here the source of light may be said to be the heat developed by surface condensation.

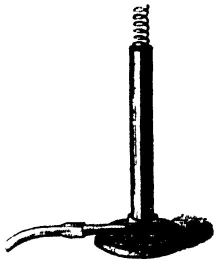
Fig. 4.

It will be evident now that light can be produced in a variety of ways—by combustion, phosphorescence, surface condensation, and electricity. There are also other ways which we need not mention here.

THE CAUSE OF LIGHT.

Now, as a piece of platinum may be raised to redness or incandescence by holding it in a hot flame, by surface condensation, or passing a current of electricity through it, light is produced in every case with nothing in common that we can see save the material of the metal platinum. We have also obtained light by the very diverse phenomena of combustion and phosphorescence. But here we have not even the same material in common. In every case, however, there are certain ultimate particles of matter which the chemist terms atoms. By physical lines of argument, founded on other experiments, one may satisfactorily contend that in each of these cases the atoms are in violent motion or vibration, and this motion in every case is partially transmitted by a common agent to the organ of sight, where it imparts the impression of light. The agent here referred to goes by the name of ether—not the ether of the pharmacist, but a subtle fluid pervading all space, extending from world to world throughout the universe, and even surrounding the atoms of substances like the carbon filament, etc. This highly elastic and invisible ether, which is so readily set in motion by the vibrating atoms of a candle flame, is supposed to transmit that motion from ether particle to ether particle as in ordinary water wave motion. You throw a stone into a pond: concentric rings of ripples spread outwards and disturb the reeds on the margin of its banks. A leaf floating midway between the point of disturbance and the bank simply rises and falls as the waves pass it, and is not carried away. From this we infer that the wave is but a *travelling form*, and that the particles of water—whilst transmitting their motion from one to another—are not bodily carried along. So in this ether motion the particles retain their relative positions, while their movement is communicated from one to another.

The following is a simple practical example of wave motion. Take a pack of cards and spread them out on the table as in Fig. 5. Lift up the end card and tilt it right over, making it describe a semi-circle with the inner edge fixed as a centre of the movement. It communicates a similar motion to the neighbouring card, and this one to the next, and so on to the end of the pack, the result being a travelling card wave, while each individual card retains its relative position.

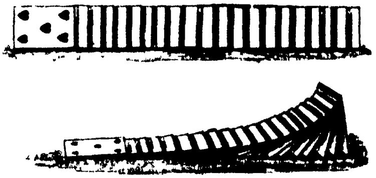
Fig. 5.

Now atomic motion—as in the candle flame—may disturb the ether particles and give rise to ether waves; in their turn the ether waves may move the atoms and molecules of substances as the reeds are moved by the water waves, and give rise to a variety of effects, chemical, physiological, electrical, or mechanical.

SOME OF THE EFFECTS OF LIGHT.

The colouring matter in the green leaves of plants has the power to decompose carbonic acid in sunlight. With the help of a chemist, this may be demonstrated as follows:—Saturate some water with carbonic acid by passing the gas through it for a while and shaking occasionally. Place it in a deep beaker A, and at the bottom of the vessel fix the common *Anacharis*, a very common water-plant (Fig. 6). Suspend a glass funnel over the plant, and over this fix an inverted test tube, T, filled with the water. Submit now to the action of bright sunlight for a few hours; a colourless transparent gas collects in the tube at T, which, upon being tested, is found to be oxygen. The ether waves have set the organism at work to decompose the carbonic acid into its constituents, carbon and oxygen, the former being retained by the plant for its growth, and the latter being given out.

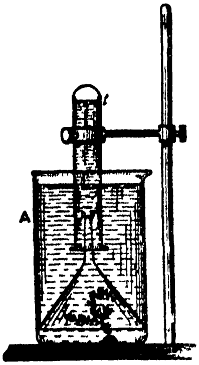

Fig. 6

Here is an example, more easily tried, of the physiological influence of light. A distant lamp or star appears to have rays spreading out from it in every direction. This arises from the peculiar formation of the eye, and the length of the rays is regulated by the size of the pupil or the expansion and contraction of the coloured ring known as the iris. Anything then which shortens these rays shows that the eye is affected, and that the iris has been made to expand. Steadily gaze at a distant lamp (Fig. 7) and at the same time strike a match in front of your face. Immediately the light from the match enters the eyes, the rays emanating from the lamp are seen to shorten. The iris has been made to expand; the ether waves have set up a physiological action in the eye.

There are some substances whose resistance to the flow of electricity in them is very much affected by the impact of light. The element selenium, for example, in its annealed state is one of the most striking examples of this variation of conductivity in darkness and light, a variation which has been taken advantage of in the construction of the *photophone*, an instrument which transmits sounds to a distance by means of a beam of light, and which we shall explain later on. Again, if two plates of silver, coated with a compound known as chloride of silver, are placed in a vessel containing water, and be then connected by means of a wire, a current of electricity is produced when light falls on one of the plates. It will be found too that if the chloride on one of these silver plates be exposed to the sunlight for a few hours, its white colour has changed to a violet, so that we have here also a chemical action set up by light. It is some such chemical change induced by light which is the basis of photography.

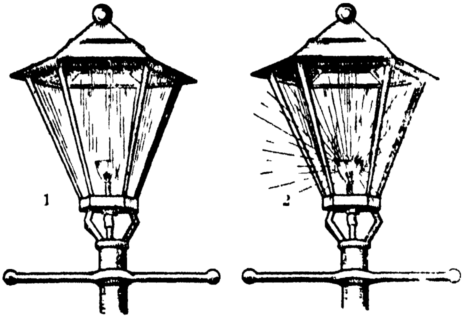

Fig. 7 —1, Before Striking Match; 2, After.

Besides these various changes which light can produce it also gives rise to effects which are more or less mechanical. One of the most remarkable of these is the movements of the vanes in Crookes' radiometer (Fig. 8). In this instrument a glass vessel is emptied as completely as possible of air, and contains some very light vanes delicately balanced; one side of the vanes is blackened and the other not. On exposing the instrument to light, the blackened sides move from the light, and with strong sunlight this may soon become a rapid revolution.

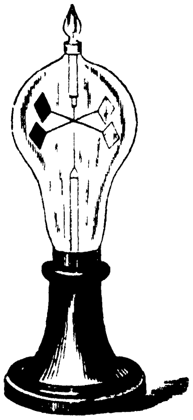

Fig. 8.

THE PERSISTENCE OF IMPRESSIONS.

We have seen a remarkable example of the action of light on the eye; more striking still are some of the phenomena of vision. Just as light enters a photographer's camera and produces a picture, so it similarly enters the eye and impresses a temporary picture on it. Now, if the light producing such a picture only lasted a hundredth of a second of time, its impression on the eye would not die out for about an eighth of a second. Hence, if a point of light occupy the positions *a* and *c* and all intermediate points in less than an eighth of a second, we appear to see a line of light *a' c'* (Fig. 9); for supposing the point of light is moving in the direction of the arrow, before the impression of *a* has died out, an infinite number of other impressions have been produced up to *c*, and these all overlap each other and give the impression of a line of light *a' c'*. This is the reason why a rapidly revolving flame appears like a fiery wheel, as, *e.g.*, in the class of fireworks known as catherine-wheels. For the same reason an artist in depicting a rain shower draws the drops as lines of rain (Fig. 10). The top of a spinning

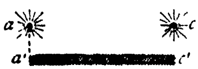

Fig. 9.

peg-top appears like a series of concentric rings, and a single spot of paint on it is drawn out into a painted ring. The fiery track of a falling star and of a flash of lightning are also examples of the persistence of visual impressions. Toys like the zoetrope and its numerous modifications are also illustrations of this phenomenon. In one of these instruments a number of phases of a given movement are rapidly presented to us in their orderly succession, and the result is that we appear to see the movement naturally gone through. Thus, for example, in eight pictures of an athlete jumping over a chair we might have four depicting phases of his ascent and the remaining four representing positions in his descent. Now if these pictures were put on the inner side of a cylinder containing slits at intervals through which these pictures could be seen one at a time as they rapidly revolved, the figure of the athlete would appear to be endowed with life and would perform a number of leaps over the chair in rapid succession. A toy like this is called a "zoetrope," or "wheel of life."

Fig. 10.

THE ORGANS OF SENSE.—I.

I.—THE EYE

The eye is the instrument by which the mind becomes acquainted with external objects by means of light, which is one of the most subtle and delicate forces in nature, and needs a correspondingly delicate and complicated organ to fully appreciate its effects.

Without inquiring into the nature of light (*see* lessons on Light), it is sufficient for our subject that we know some of its constant qualities, or laws.

In its simplest condition light travels in straight lines in all directions from its source; hence, when we see a luminous body, we know the direction in which it lies, because it must lie in the line of the ray which reaches us.

When a ray of light thus travelling in a straight line strikes upon the surface of any object, it is affected in some of the following ways according to the nature of the object and of its surface:—

1st. It may be destroyed, as far as visual effects are concerned, partially or wholly.

2nd. It may penetrate the substance of the body, being more or less bent as it traverses the surface. This occurs when the body is transparent.

3rd. It may glance off and pursue a different direction outside the object upon which it strikes.

The first effect is called absorption; the second, refraction; and the third, reflection.

Reflected light concerns us most. The eye occupies itself with reflected rays. If light were incapable of being reflected, the sun would appear as a sharply-defined dazzling orb in a pitch-dark universe, and eyes would be of no use; for though poets tell us so, not even the eagle spends its time in so profitless and injurious an employment as gazing on the sun.

Now, as reflected light travels in straight lines from the object upon which it is reflected, it is to the eye in all respects the same as though that object were itself luminous. As light proceeds from all parts of an object, and travels in straight lines, we have only to let the rays fall upon some surface which shall receive them without derangement, to get an image which will give the colour, form, and, by a little inferential reasoning, the size and distance of the object.

The first requisite in an eye, then, is a sentient mirror, which shall receive the images of objects and *feel* them.

This mirror must be of moderate and portable size, and well under control, so that it can be turned about.

All mirrors are perishable and delicate articles, liable to fracture; but when we conceive of a mirror, whose surface and backing, and even its very frame, must be made not of hard glass, imperishable quicksilver, and durable wood, but of soft renewable tissues, and think how indispensable it is that it should be protected and kept in a state of repair, we must admit that the problem of how to make a serviceable eye is a difficult one.

The analogy of the mirror, however, must not lead the reader to suppose that a plane surface, sensitive to light, would be conscious of distinct images, or that it would see objects as we, by the aid of the eye, see them reflected on its surface. For distinct vision, it is necessary that many divergent rays proceeding from each point in an object should be collected together again in a point, and that point must lie exactly on the retina, or sentient mirror. Thus, the instrument known as a camera, which has a lens set into the side of a box, and a surface at the other side to receive the image, is a more perfect simile for an eye.

We will now describe the structure of one of the most perfect instruments for taking note of the impression produced by light with which we are acquainted—the human eye.

The human eye is globular; differing, however, from a perfect sphere in some slight but important particulars. The thick, tough capsule, which maintains the eye in shape, and contains the other parts necessary to perfect vision, is about one inch from front to back, and a little more from side to side and from top to bottom. This capsule is called the *sclerotic*, or hard coat of the eye; it differs from a true sphere in that its front part, occupying about one-sixth of its circumference (in section), bulges forward far more than it would do if it were only a part of the larger globe; and this part differs from the other in texture also, for while it is equally strong and tough, and even harder, it is transparent, while the rest of the eyeball is opaque and white. This front clear portion, which is let into the hinder part as a bay-window is put into the wall of a room, or as an old-fashioned watch-glass is set into the rim of the watch-case, is called the *cornea*, or horny part. Its greater projection or convexity is not a matter of accident, but highly important, for if it were not so, no near object could be seen distinctly.

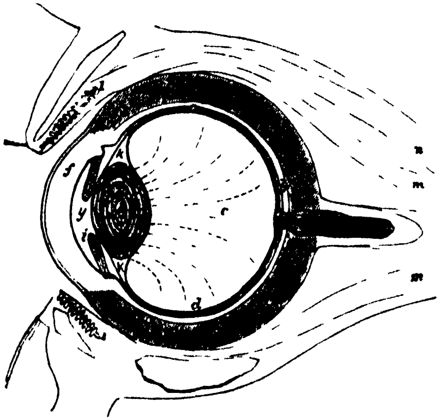

Fig. 1.—VERTICAL SECTION OF THE HUMAN EYE IN ITS SOCKET.
a, sclerotic or hard coat of the eye, *b*, choroid; *c*, retina or nervous mirror; *d*, membrane holding the vitreous humour; *e*, vitreous humour; *f*, cornea; *g*, aqueous chamber and humour; *h*, crystalline lens; *i i*, iris; *k k*, ligament to hold lens; *l*, meibomian glands; *m m*, muscles to move the eye; *n*, muscle to lift the eye-lid.

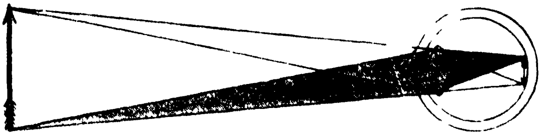

Fig. 2.—DIAGRAM SHOWING HOW OBJECTS ARE IMPRINTED ON THE RETINA.

Lining the inner surface of the sclerotic is a thin membrane, which supports in its outer layers the larger arteries and veins which carry the blood to and from the front and inner parts of the eye, while it has on its inner surface a very thin pavement of flat, six-sided cells; each cell is filled with black grains. The grains, and even the cells which contain them, are so small and so closely set as to form what appears to any but a high magnifying power a continuous thin black sheet, perfectly opaque. This membrane papers the inside of the eye as far forward as the place where the sclerotic joins the cornea, and is there connected firmly with this outer jacket by a strong ligament and muscle. Before it reaches this point, however, it is puckered into somewhat irregular fore-and-aft folds. Beyond this point the *choroid*, as this membrane is called, is continued as a freely hanging curtain, shaped like a quoit—that is, round and opaque, with a hole in the middle; this hole is opposite the middle of the cornea, or window of the eye.

From the same circle of attachment, but internal to the curtain before named, is suspended, or rather held, by a ligament, a perfectly transparent body shaped like a lentil—that is, with two convex but flattened surfaces. The quoit-like curtain is called the *iris*, and the disc the *crystalline lens*. The lens is slung at some little distance from the cornea, leaving a chamber in front of it, which is filled with watery fluid. Behind the lens, and occupying the larger part of the hollow of the eye, is a denser liquid, contained in a thin, perfectly transparent membrane, which not only encircles it, but sends in partitions from its outer wall to divide the liquid into compartments, so that when the eye is cut into, the humour does not run out, but seems to be of the consistence of clear jelly. Both the liquid and capsule are so transparent that they are called the *hyaloid membrane* and *vitreous humour*, or the glassy membrane and humour.

All the main parts of the eye have now been described except the essential one for which all the others are made, namely, the retina—that wonderful stratum of nervous matter which receives and transmits to the brain all luminous impressions, the glories of colour, the splendid imagery of the earth, and the soft radiance of the sky.

The retina lies between the choroid and vitreous humour. It lines the choroid as closely as that membrane lines the sclerotic, and so covers the whole back part of the eye.

The retina (or sentient mirror), thin as it is, has been found under the microscope to consist of many layers of diverse structure. Not to descend into great minuteness, it may be said to consist of an outer layer of cylindrical bodies, called, from their shape, rods and cones, which run perpendicularly to the surface of junction between retina and choroid. These bodies are the instruments by which the rays are noted. It would seem that each rod or cone conveys but one impression, so that while the image of an external object may be made very small on the retina, and yet distinctly seen, because of the minuteness of these bodies, yet the image must cover a certain number of them to be an image at all. In other words, if it only covered one, the impression would be that of a single point of light.

The innermost layer, or that nearest the vitreous humour, consists of nerve-fibres, which convey the impressions in some such way as the telegraph wires convey their messages. These all run to one point in the back part of the eyeball, a little on the inner or nose side of the axis, where they pass through the choroid and sclerotic, which are pierced by a great many holes; the fibres become united behind into the optic nerve, and this runs to the brain, first, however, being joined by its fellow from the other eye, and then separating from it again, having received some of the strands of that nervous cord, and having given up some of its own in return.

Let us now trace the course of a number of rays reflected from a single point of an object, before they reach the retina (*see* Fig. 2). These rays as they come from a single point are, of course, diverging. They strike, therefore, all over the surface of the cornea, and as they pass through it are gathered somewhat together. They then pass the aqueous humour with a slightly altered course. The outermost are cut off by the opaque iris, but the central ones pass through the lens, which rapidly gathers them together, and they are then transmitted through the vitreous humour, all the time converging until they meet at a point exactly in or on the retina.

In saying that they meet exactly on the retina, it is meant that they will do so if the adjustment is perfect. If it be imperfect, so that the rays unite in a point either before the retina, or would unite behind it if they could traverse the choroid, the image is blurred and indistinct.

The problem of how to get a distinct image is, of course, more difficult when the points from which the light proceeds are numerous, as from any object of appreciable form. To obtain this, the surface of the cornea, the hind and front face of the lens, and the face of the retina, must be all of definite and regular curves, or the figure would be distorted. If the cornea bulges too much, the object can only be seen at a short distance, and from this cause some persons have to lay their cheeks upon the page before they can read print. If it bulges too little, distinct images of near objects are impossible. If the crystalline lens is too dry, or too moist, it becomes clouded with hard or soft cataract. If the pigment be not of sufficient quantity in the choroid, vision is interfered with; and from this cause albinos, or persons whose hair and skin are deficient in colouring matter, are dazzled in ordinary daylight.

Further, if the retina, or part of it, fail, as it sometimes does, from some cause too subtle to be found out, the object is seen only in part; thus, some persons have this peculiar affection of half the retina, so that when they look directly at an object, they only see the half of it.

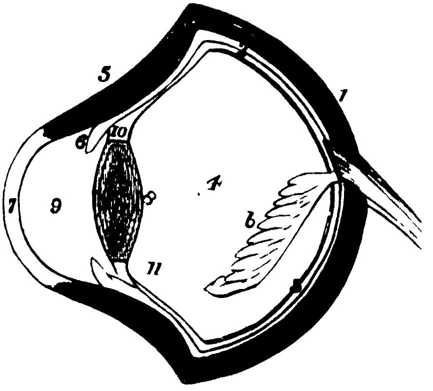

Fig. 3.—Vertical Section of the Eye of a Soaring Bird.

1, sclerotic; 2, choroid; 3, retina; *b*, pecten; 4, vitreous humour; 5, bony supports of sclerotic or hard coat; 6, iris; 7, cornea; 8, lens; 9, aqueous humour; 10, lens ligament; 11, ciliary processes; 12, optic nerve.

The retina, perfect in all its other functions, does not always discriminate colour. The writer once played a game at croquet with a gentleman, who disclosed his infirmity thus: Two balls were lying together—one red, and the other green. He asked which was his, and being told the red one, asked which red one? On another occasion the writer was looking at a brightly coloured geological map. A stranger who looked with him soon showed that he was quite unaware that it was other than the ordinary ordnance map.

These defects of vision call marked attention to the comparative perfection of the instrument of vision in most cases, but, had we space to examine closely into the details of structure, we should find a number of imperfections; in, for example, the irregularity of the refractive power of parts of the lens, the common deviations from the perfect sphere which produce astigmatism, and the want of perfect transparency which causes us at times to see objects (really floating in the vitreous humour) floating before our eyes.

Throughout those classes of animals which are called vertebrate, because they have an internal skeleton, the main central portion of which consists of a back-bone of pieces jointed to one another in a long row stretching from one end of the body to the other, the eye is essentially of the same structure as in man. It is true there are differences in the proportion and shape of the parts, and in some cases additional parts are found, while in others the eye is so reduced and degraded as to be of little or no use; but in the majority of cases in brutes, reptiles, and fishes, and in all birds, the eye is well developed, and even where it can be of no use, still indications of it are found.

Our English mole is an instance of an animal with a degraded condition of eye. It is in this animal smaller than a pin's head, and has to be looked for carefully in the midst of the velvet fur. Of course, to an animal which lives underground, burrowing continually in soft earth, an eye would be useless, and even inconvenient; yet the rudiment of an eye is found.

Vision, on the other hand, in some apes must be very powerful, for it is said a gentleman who owned a baboon used to ride away across the plain until he could only just see his dog ape with the naked eye; then using his telescope, he made a number of gestures, which were immediately mimicked with precision by the animal.

In looking into the open eye the white is part of the opaque sclerotic. The coloured part is the iris seen through the transparent cornea and aqueous humour, while the pupil is the hole through the middle of this, which seems black because of the dark non-reflecting choroid at the back of the eye.

The iris affects the colour of the eye, the primary cause of which is the red blood circulating in it. Thus, the lack of pigment is sometimes so great that even the choroid has none, and then the pupil looks red because the blood-vessels of the choroid can be seen through its front layer. Albinos, as individuals with the last peculiarity are called, are found among rabbits, mice, cats, and many other species, and are especially prone to occur under domestication. These creatures present an appearance which is very ethereal and fairy-like, so that artists have often introduced them into their fanciful pictures, as in Landseer's "Bottom and Titania." But however they may grace the ideal creation of the painter, they are less suited to this working-day world than their coarser brothers. When there is only a layer of pigment on the back part of the iris, the eye is blue; but when, in addition, specks or sheets of pigment are distributed through the substance of the iris, eyes of various colours are produced. Thus, fair people have usually blue eyes, and black eyes accompany an olive complexion and dark hair. In other words, people that have a surplus of internal paint elsewhere have it in the iris too. On the other hand, in some species a further deposit takes place in the choroid of pigment of metallic brilliancy.

These diversities, with many others, such as the contraction of the iris of the cat, so as to leave a slit instead of a circular opening, are interesting, but by no means so functionally important as others to be mentioned hereafter, when we describe eyes suited to conditions altogether different, such, for instance, as the fish's eye, which is constructed to see in water.

Birds, some of which are almost exclusively denizens of the air, and most of which have the power of betaking themselves to flight occasionally to escape pursuit, to hunt active prey, to search for new feeding-grounds, or to select a more genial climate at the change of the seasons, must have eyes suited to distant vision (Fig. 3). Hence the lens is of a very flattened form, and does not increase in density from the outside to the inside as it does in mammalia, and more strikingly in fish. The distance from the lens to the back part of the eye is small, and to the cornea large relatively; in other words, they have a larger amount of aqueous and a smaller amount of vitreous humour than brutes have. The back part of the eye too is flatter, and is a portion of a larger sphere in relation to the rest of the eye than in animals. The shape will be best seen by the aid of the diagram of the vertical section of the eye of a soaring bird.

When the eye is spherical and distended with fluid, as in man, there is no tendency of the pressure within to alter the shape of the ball; but when, as in the case of birds, it has any other form, the internal pressure would strain the elastic capsule of the eye in some parts more than in others. This strain can only be prevented by rendering those parts of the capsule which are exposed to the extra pressure more solid. In the case of the bird, this is effected by means of a series of bony plates which encircle the sclerotic, bedded in its substance, and stretch from the rim of the cornea to the circumference of the large segment of the eye, on the inside of which the retina is spread out.

LATIN.—XXXVIII.

[*Continued from p. 65.*]

LATIN READINGS (*continued*).

HORACE.

QUINTUS Horatius Flaccus was born at Venusium in the year 65 B.C., and died 8 B.C., in his fifty-seventh year. He was the greatest of all the lyric poets of Rome, and his Satires, though not so biting and pungent as those of Juvenal, the acknowledged master of that branch of literature, are marked by a keen sense of humour and a power of observation. He has left us four books of Odes and one book of Epodes in various lyric metres, two books of Satires, two books of Epistles, and the "De Arte Poetica," a treatise in hexameters on the art and practice of versification. There is an occasional obscurity in his language, and especially in the Satires and Epistles there are allusions to the events of his time to which it is difficult to find a key; but for the most part his writings are easy and graceful, and but few of the Odes present any but ordinary difficulties to the reader. The following extract is the ninth ode of the first book; it is addressed to his friend Thaliarchus, and requires no further introduction. It is in the Alcaic measure, so called from the Greek poet Alcæus, who employed it, and was credited with its invention :—

HORACE.—ODES, I. ix.

Vides ut altâ stet nive candidum
Soracte, nec jam sustineant onus
Silvae laborantes, geluque
Flumina constiterint acuto.

Dissolve frigus, ligna super foco
Large reponens, atque benignius
Deprome quadrimum Sabina,
O Thaliarche, merum diota.

Permitte divis caetera, qui simul
Stravere ventos aequore fervido
Deproeliantes, nec cupressi
Nec veteres agitantur orni.

Quid sit futurum cras, fuge quaerere; et
Quem sors dierum cunque dabit, lucro
Appone: nec dulces amores
Sperne puer neque tu choreas,
Donec virenti canities abest
Morosa. Nunc et campus, et areae,
Lenesque sub noctem susurri
Composita repetantur hora,

Nunc et latentis proditor intimo
Gratus puellae risus ab angulo,
Pignusque dereptum lacertis,
Aut digito male pertinaci.

NOTES.

Stet, "stands out," owing to the greater clearness of the atmosphere. In summer the outline of the hills would be dim and hazy.

Soracte, a hill in the territory of the Falisci, about twenty-four miles from Rome, now called Monte di S. Oreste.

Acuto. So Pindar speaks of χιόνος ὀξείας, and we use the phrase "piercing cold." *Constiterint*, as having a passive sense, "have been stopped," takes *gelu* as a kind of ablative of the agent.

Sabina, generally described by Horace as a poor wine, *vile Sabinum* (Ode I. xx. 1), but this would be mellowed by having been kept for four years (*quadrimum*).

Diota, a two-handled jar (δις ; ους, ὠτος, the ear), ablative of the place *whence* a thing proceeds.

Simul more generally would be *simul ac stravere*, "as soon as they have quieted."

Aequore, ablative of place.

Deproeliantes, "fighting it out." The *de* has a sense of completing a thing, doing it thoroughly.

Fuge quaerere, "seek not to know." The infinitive is used as the object of (accusative case after) *fuge*, by a frequent construction borrowed from the Greek So Vergil ("Æneid," ix. 200), *adjungere rebus Nise fugis?* where *adjungere* is the object of *fugis*.

The construction is *quem cunque* [*diem*] *dierum Fors dabit*, "whatever sort of day Fortune gives, count it a gain." *Lucro appone*, "set it down to the profit side of the account."

Areae, "open places," around temples, for example.

Repetantur, "be sought for at the appointed hour."

Pignus, either a "bracelet" (*lacertis*) or a "ring" (*digito*).

Male pertinaci, "that ill feigns resistance."

The following ode is addressed to some fickle fair one who had betrayed the poet, who now congratulates himself on his escape :—

HORACE.—ODES, I. v.

Quis multa gracilis te puer in rosa
Perfusus liquidis urget odoribus
Grato, Pyrrha, sub antro?
Cui flavam religas comam

Simplex munditiis? Heu, quotiens fidem
Mutatosque Deos flebit, et aspera
Nigris aequora ventis
Emirabitur insolens,

Qui nunc te fruitur credulus aurea;
Qui semper vacuam, semper amabilem
Sperat, nescius aurae
Fallacis. Miseri quibus

Intentata nites? Me tabula sacer
Votivâ paries indicat uvida
Suspendisse potenti
Vestimenta maris Deo.

NOTES.

In rosâ, "on a couch strewn with roses."

Simplex munditiis, "plain in thy neatness." *Fidem*, "the confidence which he reposed in you deceived." Supply *falsam*.

Mutatos Deos, "changed fortune."

Aequora. The poet compares Pyrrha's changing humours to the fickleness of the weather. Like many others he has been shipwrecked on her smiles, but he has got safely through it. *Nigris*, "black and scowling," probably as bringing up the black storm-clouds.

Emirabitur, a strengthened form of *miror*, occurring only in this passage.

Me tabula, etc. The construction is—*Paries sacer indicat votivâ tabula me suspendisse vestimenta uvida Deo potenti maris*, and the allusion is to a custom of the Italian sailors, on escaping from shipwreck, to put up a votive tablet in the temple of Neptune, or some other sea deity, together with the clothes in which they were preserved.

Maris probably is governed by *potens*, according to a Greek construction, by which verbs of ruling govern a genitive case—for example, *Sic te Diva potens Cypri* (Odes, I. iii. 1).

The next extract is from the Satires, and is the beginning of an amusing description of the way the poet was pestered in the street by a person who persisted in fastening on to him. The whole satire is peculiarly bright and vivid, and the description is so true to life that it is as applicable at the present day as at the time when it was written.

HORACE.—SATIRES I. ix.

Ibam forte Via Sacra, sicut meus est mos,
Nescio quid meditans nugarum, totus in illis:
Accurrit quidam notus mihi nomine tantum,
Arreptaque manu, "Quid agis, dulcissime rerum?"
"Suaviter, ut nunc est," inquam; "et cupio omnia quae vis."
Quum assectaretur, "Numquid vis?" occupo. At ille,
"Noris nos," inquit. "Docti sumus." Hic ego, "Pluris
Hoc," inquam, "mihi eris." Misere discedere quaerens,
Ire modo ocius, interdum consistere, in aurem
Dicere nescio quid puero; quum sudor ad imos
Manaret talos. "O te, Bolane, cerebri
Felicem!" aiebam tacitus; quum quidlibet ille
Garriret, vicos, urbem laudaret. Ut illi
Nil respondebam, "Misere cupis," inquit, "abire;
Jamdudum video; sed nil agis, usque tenebo;
Persequar. Hinc quo nunc iter est tibi?" "Nil opus est te
Circumagi; quendam volo visere, non tibi notum;
Trans Tiberim longe cubat is, prope Caesaris hortos."
"Nil habeo quod agam, et non sum piger—usque sequar te."

NOTES.

Via Sacra, one of the principal streets of Rome, leading up to the Capitol through the Forum, from where the Arch of Constantine now stands. It was called sacred as being the route followed by triumphal processions and religious pageants.

Quid agis. The common form of salutation in Rome. Where we say, "How do you do?" the Romans said, "What do you do?" *Rerum* goes with *dulcissime*, not *quid*.

Ut nunc est, "as times go."

Occupo, "I ask him at once."

Pluris, etc. "'On this account,' I reply, 'you will be more esteemed by me.'" *Pluris* is the genitive of price.

Puero, the slave whom Horace had in attendance, according to the fashion of the day.

Bolane cerebri felicem, "I wish you were here, Bolanus, with your coolness," apostrophising some outspoken friend, who would have got rid of the fellow summarily. *Cerebri*, genitive, signifying with respect to. So Pliny has *Miseros ambitionis*, and in Greek we find, εὐδαίμων τῶν λόγων.

Jamdudum, etc., "I've seen it all along, but it's no use."

Circumagi, "there is no need for me to take you out of your way."

Caesaris hortos, the gardens on the Janiculum, which Cæsar, when dictator, had assigned to the people as a public pleasure-ground.

The following are some of the canons for the treatment of dramatic subjects which Horace lays down in the "De Arte Poetica."

HORACE.—DE ARTE POETICA, 179.

Aut agitur res in scenis, aut acta refertur:
Segnius irritant animos demissa per aurem,
Quam quae sunt oculis subjecta fidelibus, et quae
Ipse sibi tradit spectator. Non tamen intus
Digna geri, promes in scenam; multaque tolles
Ex oculis, quae mox narret facundia praesens.
Nec pueros coram populo Medea trucidet,
Aut humana palam coquat exta nefarius Atreus,
Aut in avem Progne vertatur, Cadmus in anguem.
Quodcunque ostendis mihi sic, incredulus odi.

NOTES.

Aut acta refertur, "or its occurrence is related." The drama consists partly of action, partly of narrative; and the action which the spectators see with their own eyes naturally impresses them more strongly than that of which they merely hear secondhand. Still, there are subjects which, either from their being repulsive or unnatural, should be described rather than enacted, as the Greek poets have done in the case of Medea's murder of her children, or Artreus' horrible feast, or the unnatural transformations of Progne and Cadmus.

Segnius irritant, "impress less vividly."

Fidelibus, "on the evidence of which he can depend."

Quae ipsi sibi tradit, "and for which he is his own authority." *Intus digna geri*, "things which ought to be kept behind the scenes."

Mox, "in due time."

Pueros. In Euripides' play of "Medea," the cries of the children are heard on the stage, but the actual murder is not shown. If you choose such subjects as Medea or Atreus, you must treat the horrors of the story in the same way as the old Greek poets did.

Quodcunque, etc., "anything you show me in this way is repugnant to my reason and my taste."

LIVY.

Titus Livius, the greatest of the Roman historians, was born at Patavium, the modern Padua, about 60 B.C., and died in the year 20 A.D. From the name of his birthplace he is called *Patavinus*, and the occasional provincial expressions which some critics have affected to detect in his style have been called, from the same cause, *Patavinitas*. He is said, in his earlier years, to have published some works on rhetoric, but the recollection of these has been eclipsed by the magnificence and colossal proportions of his history of Rome from the earliest period down to his own days. Of this work comparatively a small portion has reached us. It is believed that he intended to complete it in 150 books, divided into fifteen *decads* or sets of ten books each, and of these he wrote 142. All that are extant in their entirety are the first, third, and fourth decads—in other words, Books I.—X. and XX.—XL. The only other remains are abstracts of the contents of all the 142 books, with the exception of Books CXXXVI. and CXXXVII., and a few isolated fragments. Though marred by occasional obscurities, the style of Livy's writing is, as a whole, remarkably pure and elegant, and his descriptions are always forcible and picturesque. As a statement of facts his account of the early period of Roman history is not to be depended upon, though for a long time it was accepted as true; and it was reserved for Niebuhr, one of the greatest of German scholars, to show that Livy had, in the absence of more reliable authorities, merely taken for granted and repeated the stories of the old annalists, which were in point of fact little better than fabulous, without taking the trouble to examine them critically; but as the work proceeds it increases in historical value. Niebuhr says of him, "Few authors have exercised an influence like that of Livy; he forms an era in Roman literature; and after him, no attempt was made to write Roman annals. His reputation was extraordinary. It is well known that one man came from Cadiz to Rome merely to see Livy; and this reputation was not ephemeral; it lasted and became firmly established. Livy was regarded as *the* historian, and Roman history was learned and studied from him alone. He threw all his predecessors into the shade, and nearly all subsequent historians confined themselves to abridging his work."

According to the early legends, the original inhabitants of Rome were almost entirely men, and being mostly criminals and runaway slaves, they found it impossible to obtain any of the women of the neighbouring states in marriage. In this difficulty, Romulus, the king and founder of the city, had recourse to an artifice. He invited the Sabines to a festival at Rome, and they came without suspicion, bringing their wives and daughters; but in the midst of the festivities the Romans rushed on them with drawn swords, and carried off a great number of the women (the rape of the Sabines). War ensued, and a battle was fought which seemed likely to have ended in the total destruction of the Sabine army. At this crisis our first extract comes in:—

LIVY, I. 13.

Tum Sabinae mulieres, quarum ex injuria bellum ortum erat, crinibus passis, scissaque veste, victo malis muliebri pavore, ausae se inter tela volantia inferre, ex transverso impetu facto dirimere infestas acies, dirimere iras, hinc patres, hinc viros orantes, ne sanguine se nefando soceri generique respergerent, ne parricidio macularent partus suos, nepotum illi, hi liberum progeniem. "Si affinitatis inter vos, si connubii piget, in nos vertite iras: nos causa belli, nos vulnerum ac caedium viris ac parentibus sumus, melius peribimus quam sine alteris vestrum viduae aut orbae vivemus." Movet res quum multitudinem, tum duces; silentium et repentina fit quies: inde ad foedus faciendum duces prodeunt, nec pacem modo sed civitatem unam ex duabus faciunt, regnum consociant, imperium omne conferunt Romam. Ita geminata urbe ut Sabinis tamen aliquid daretur, Quirites a Curibus appellati.

NOTES.

Quarum ex injuria. The genitive of the object: "from the injury done to whom."

Victo, ablative absolute, agreeing with *pavore*: "the fear natural to their sex being overcome by the horrors of the scene."

Impetu facto, "rushing across," between the combatants.

Patres—viros, their fathers, who were Sabines; their husbands, the Romans, who had forcibly married them.

Ne sanguine, etc., "not to stain themselves with impious blood; these of their fathers-in-law, the others of their sons-in-law."

Nepotum—liberum, grandsons to their fathers, the Sabines; sons to their husbands, the Romans.

Si affinitatis, "'If,' they say." The construction changes from the *oratio obliqua* to the *oratio recta*, in which the actual words of the speakers are reported.

Melius, "it will be better for us to die.

Quum—tum, "first one, then the other," and so "both, and."

Conferunt Romam, literally "they bring together to Rome; they concentrate at Rome." *Romam*, accusative of motion to a place.

KEY TO TACITUS (*continued*).

43. The end of his life brought mourning to us, grief to his friends, and was no matter of indifference even to strangers and such as knew him not. The commonalty likewise, and this people occupied with other interests, were not only frequent in their visits to his house, but talked of him in public places and in private companies. Nor, when news of the death of Agricola was heard, was there a soul found who either rejoiced at it, or at once forgot it. What heightened the general sympathy was a persistent rumour that he was despatched by poison. I dare not assert that aught was ascertained. Yet it is true, that during the whole of his illness, both the chief freedmen and the most trusty physicians of the Emperor came with more frequency than is usual to a Court which pays its visits by means of messengers—whether this was due to concern or to curiosity. It is known that on his last day the very fluctuations of his failing strength were reported by messengers placed at intervals, and no one believed that the Emperor would quicken tidings that he would hear with sorrow. In his dress, however, and even in his expression, he affected to show some guise of grief; for he was now secure against the object of his hate, and could more easily dissemble his joy than his fear. It was well known that upon reading the will of Agricola, in which he left him joint heir with his excellent wife and most dutiful daughter, Domitian rejoiced as though the choice conferred honour upon himself. So blind and corrupt was his mind rendered by continual flattery, as not to know that only a bad prince is appointed heir by a good father.

44. Agricola was born on the 13th of June, during the third consulship of Gaius Cæsar, He died on the 22nd of August, during the consulship of Collega and Priscus, in the fifty-sixth year of his age. If posterity be desirous to know his stature, he was rather comely than commanding. In his aspect there was nothing terrible. He possessed, moreover, charm of expression. You would readily believe him a good man, and gladly believe him a great man. In himself, too, though he was snatched away whilst his age was yet in full vigour, as far as glory be considered, his life was long. For all true blessings, such as arise from virtue, he had enjoyed to the full. As he had been likewise dignified with the consular and triumphal honours, what more could fortune add? In enormous wealth he found no joy: an honourable share had fallen to his lot. As his daughter and his wife he left surviving, he may be even accounted happy in that, with his honour unimpaired, his fame in its full splendour, his kinsfolk and friends yet safe, he escaped the evils to come. For, as it was not permitted him to survive till the dawn of this most blessed age, and see a Trajan as his prince (a fate he had prophesied with auguries and prayers in my hearing), so he gained a great compensation in his hastened death in having escaped that last fatal period, in which Domitian, no longer leaving intervals and breathing-times, drained the forces of the State, as it were, by one continuous stroke.

45. For, Agricola saw not the senate house besieged, nor the senate shut in by armed men nor the butchery of so many men of consular dignity, nor the flight and exile of so many of the noblest ladies, all effected in one and the same havoc. Till then Carus Metius, the accuser, was only considerable for one victory; till then the opinion of Messalinus was heard within the palace at Alba; and in those days Massa Bæbius was himself on his trial. Soon our hands dragged Helvidius to prison; the gaze of Mauricus and Rusticus thrilled us; Senecio sprinkled us with his innocent blood. Nero, however, withheld his eyes from scenes of cruelty, and ordered crimes he gazed not on. The chief part of our miseries under Domitian was to see and be seen when our sighs were marked down; when for registering the pale looks of so many men that cruel countenance of his was ready, covered with that red hue with which he protected himself against all shame. Thou, therefore, Agricola, art blessed, not only in the glory of thy life, but even in the season of thy death. As they tell who were present at thy last words, thou didst accept thy fate with firm and cheerful mind, as if thou thus didst thy part to show the Emperor to be guiltless. But to myself and thy daughter, besides the bitterness of having our father snatched from us, our sorrow is increased that it was not our lot to attend thee in thy sickness, to cherish thee in thy sinking moments, to satisfy ourselves with seeing thee, with embracing thee. Surely we should have received thy precepts and thy words to engrave deeply on our hearts. Ours is this grief, ours this wound, that by the lot of long absence thou wast lost to us four years before thy death. There is no question, best of fathers, but that with thy most loving wife at thy side, all things were done befitting thy honour: yet with tears too few wert thou mourned, and on thy last day thine eyes longed for something in vain.

46. If for the souls of the just any place be found; if, as philosophers hold, great spirits perish not with the body, quiet be thy repose; recall us thy family from weak regret and effeminate wailings to the contemplation of thy virtues, for which it were impious to lament or to mourn. Let us do thee honour by admiration rather than by fleeting praises, and if nature gives us strength, by emulating thy virtues. This is true honour, this the natural duty of every near relation. This lesson also I would commend to thy daughter and thy wife, so to reverence the memory of a father and a husband, as to be ever meditating on all his deeds and all his sayings, and cherish the form and figure of his mind rather than that of his person. Not that I mean to set my ban on statues framed of marble or bronze. But as the faces of men are frail and perishing, so are the images of the face. The form of the soul is eternal, such as you cannot represent and preserve in any foreign substance or by art, but only in your own character. Whatever we loved in Agricola, whatever we admired, remains and will for ever remain implanted in the hearts of men, through an eternity of ages in the record of the world. For many of the great ancients, oblivion will overwhelm as if they were without glory and without note; but Agricola, his deeds recorded and transmitted to posterity, shall ever survive.

KEY TO SALLUST.

"CATILINA," V.

Lucius Catilina, the son of a distinguished house, was a man endowed with great capacities, both of mind and body, but he had a wicked and perverse disposition. From his boyhood he had revelled in the scenes of intestine strife, murder, rapine, and civil broil, which became his pursuits on arriving at manhood. Gifted with a constitution capable of enduring to an almost incredible degree fasting and want of sleep, with a mind courageous, cunning, and shifty, capable of pretence or concealment to any extent; covetous of his neighbour's money, lavish of his own; outrageous in his desires; with plenty of eloquence but little wisdom to guide it; in his boundless ambition, ever straining after some extravagant object beyond the belief or aim of ordinary men: this man, ever since Lucius Sulla's dictatorship, had been fired with an irresistible desire to seize the reins of the State, and, provided he could gain the regal power he aimed at, he cared not one jot by what means it was to be attained. Day by day his views became more and more outrageous, as he was spurred on by his want of money and the recollection of his crimes, to both of which results his former courses had contributed. An additional

incitement was found in the corrupt state of morality in Rome, which was cursed by two abominable evils differing widely in their nature—luxury and avarice.

GREEK.—XV.

[*Continued from p. 68.*]

THE FUTURE AND FIRST AORIST MIDDLE AND THE PERFECT FUTURE.

THE future middle is formed from the future active by changing the personal ending of the active (that is, -ω) into the personal ending of the middle (that is, -ομαι): as λύσ-[illegible]λύσ-ομαι. The ο here may be considered as a connecting vowel, and the mood be divided thus—λύ-σ-ο-μαι. Of each of these four parts the student should be able to give an account.

The first aorist middle is formed from the future middle by prefixing the augment, and changing -ομαι into -αμην—thus, λύσ-ομαι, ἐ-λυσ-άμην

The form of the perfect future—or, as it is sometimes called, the third future (also the *paulo-post-futurum*)—may be seen by changing -αι of the second person singular of the perfect passive into -ομαι, as λέλυσ-αι, λελύσ-ομαι—where again ο may be accounted a connecting vowel as well as the modal vowel, or vowel marking the indicative mood. For the optative, ο becomes οι, as λελυσοίμην—that is, ι is added to ο.

The principal parts of παύω are, παύω, παύσω, πέπαυκα, πέπαυμαι; the future middle, παύσομαι; first aorist middle, ἐπαυσάμην; perfect future, πεπαύσομαι.

VOCABULARY.

Ἀναπαύω, I cause to rest (in the middle, *I rest*).

Γεύω, I let taste; in the middle, *I taste* (with genitive).

Ἐπιτηδεύω, I attend to, I prosecute, practise.

Παύω, I make to cease (in the middle, *I cease* or *stop*).

Πολιτεία, -ας, ἡ (from πόλις; hence our *police, policy, politic, political, polity*), a state, constitution, government.

Πορεύω, I bring, bring forward (in the middle, *I go, proceed, travel*).

Πύλη, -ης, ἡ, a door, gate.

EXERCISE 82.

Translate into English:—

1. Οἱ πολέμιοι ἐπὶ τὴν ἡμετερὰν πόλιν στρατεύονται. 2. Περὶ τῆς τῶν πολιτῶν σωτηρίας βουλευσόμεθα 3. Ὁ πατήρ μοι ἔλεγεν ὅτι πορεύσοιτο. 4. Οἱ Ἕλληνες ἐπὶ τοὺς Πέρσας ἐστρατεύσαντο. 5. Ἀναπαυσώμεθα, ὦ φίλοι. 6. Πρὸ τοῦ ἔργου εὖ βούλευσαι. 7. Πάντες τίμης γεύσασθαι βούλονται. 8. Ὁ πατὴρ ἀναπαυσάμενος πορεύσεται. 9. Αἱ πύλαι τῆς νυκτὸς κεκλείσονται. 10. Ἐὰν τοιοῦτος ἀνὴρ τὴν πολιτείαν ἐπιτηδεύῃ, εὖ βεβουλεύσεται.

Note.—Πορεύσοιτο, the optative, because it is in *Oratio Obliqua* after an historic tense.

Ἀναπαυσάμενος, *having rested*—that is, *when he has rested*. The force of the participle in Greek can often be given in English only by an adverbial sentence.

Τῆς νυκτός, *by night*, the genitive of time. (*See* the Syntax.)

EXERCISE 83.

Translate into Greek:—

1. I shall have been educated. 2. They will have been planted. 3. He will have been slain. 4. The general will march to the city. 5. The generals marched to the city. 6. I wish the general would march to the city. 7. We shall have consulted respecting the safety of our native land. 8. He will consult respecting thy safety. 9. He consulted respecting the safety of the citizens. 10. They ceased. 11. They will have ceased. 12. The two men ceased. 13. We will cease, O friends. 14. The friends travel.

THE FIRST AORIST AND THE FIRST FUTURE PASSIVE.

The first aorist passive is formed from the stem of the perfect active by changing -κα into -θην, and by changing the reduplication into the syllabic augment, as λέλυκα, ἐλύθην.

The first future passive is formed from the first aorist passive by dropping the augment and changing -ν into -σομαι, as ἐλύθην, λυθήσομαι.

VOCABULARY.

Δημοκρατία, -ας, ἡ, democracy, the government of the δῆμος, *or* people (that is, *the populace*).

Ἐπιφέρω, I bring upon, I introduce; πόλεμον τινι (Latin *bellum infero*), to make war on.

Μή, not, lest (Latin *ne*).

Πολέμιος, -α, -ον, hostile, the enemy's.

Συνθήκη (σὺν *and* τίθημι), a convention, agreement, treaty (in the text, used in the plural, *the agreements*—that is, the treaty considered as containing many heads).

Τύραννος, -ου, ὁ, a tyrant.

EXERCISE 84.

Translate into English:—

1. Ἕκτωρ ὑπὸ Ἀχιλλέως ἐφονεύθη. 2. Τὼ ἀδελφὼ ὑπὸ τοῦ αὐτοῦ διδασκάλου ἐπαιδευθήτην. 3. Πολλαὶ δημοκρατίαι ὑπὸ τῶν τυράννων κατελύθησαν. 4. Μέγας φόβος τοὺς πολίτας ἔχει, μὴ αἱ συνθῆκαι ὑπὸ τῶν πολεμίων λύθωσιν. 5. Εἴθε πάντες νεανίαι καλῶς παιδευθεῖεν. 6. Φονεύθητι, ὦ κακοῦργε. 7. Οἱ στρατιῶται εἰς τὴν πολεμίαν γῆν πορευθῆναι λέγονται. 8. Οἱ πολέμιοι, τῶν συνθηκῶν λυθεισῶν, ἡμῖν πόλεμον ἐπιφέρουσιν. 9. Ὁ λῃστὴς φονευθήσεται.

Ex. 75.—1. Ὁ στρατηγὸς τὴν πόλιν ἀπὸ τῶν πολεμίων ἀπολύσει. 2. Οἱ χρηστοὶ ἄνθρωποι καὶ τοῖς ἐκγόνοις φυτεύουσιν. 3. Οἱ ἄγγελοι πολλὰ ἐπαγγέλλουσιν. 4. Οἱ πολέμιοι ἐπιβουλεύουσι τῷ βασιλεῖ. 5. Οἱ πολέμιοι ἐμοὶ ἐπιβουλεύουσιν. 6. Πολλὰ τοῖς πολίταις ἐπαγγελῶ. 7. Ἀχιλλεὺς Ἀγαμέμνονι μηνίσει. 8. Σὺ τῷ ἀδελφῷ μηνίεις. 9. Ἐμήνισα τοῖς πολεμίοις. 10. Τοὺς δικαστὰς ἱκετεύσω. 11. Οἱ χρηστοὶ πολῖται οὐκ ἱκετεύσουσι τοὺς δικαστάς. 12. Οἱ πολέμιοι Πλαταίας καταλύουσιν. 13. Οἱ στρατιῶται Πλαταίας καταλύσουσιν. 14. Οἱ στρατιῶται τὴν πόλιν κατέλυσαν. 15. Ἀκούσατέ μου, ὦ ἔγκονοι. 16. Ἑταῖρος ἑταίρῳ πιστεύσει. 17. Ἑταῖρος ἑταίρῳ ἐπίστευεν. 18. Πιστεύσεις. 19. Ἐπιστευσάτην. 20. Πιστεύσομεν. 21. Ὁ στρατιώτης τῇ ἀνδρείᾳ πολλὰ ἰσχύει. 22. Ἐγὼ τῇ ἀνδρείᾳ πολλὰ ἴσχῦσα.

Ex. 76.—1. The soldiers have slain two thousand two hundred and sixty-five of the enemy. 2. Pherecydes used to say that he had sacrificed to no god. 3. As you are (*having been produced*) young, learn many good things. 4. The soothsayer has foretold the future well. 5. You have instructed your children well. 6. Medea, having slain her children, rejoiced. 7. The Lacedæmonians had destroyed Platæa. 8. Sardanapalus had put on a woman's garment. 9. When the sun had set, the enemy approached. 10. Alexander, in his pursuit of Darius the king of the Persians, had made himself master of great wealth.

Ex. 77.—1. Πεφόνευκα. 2. Πεφονεύκασιν. 3. Ἐπεφονεύκει. 4. Φονεύσουσιν. 5. Ἐφόνευσεν. 6. Φονεύσομεν. 7. Πεφονεύκαμεν. 8. Ἐπεφονεύκεμεν. 9. Θύσουσιν. 10. Τεθύκασιν. 11. Ἐτεθύκεσαν. 12. Ἔθυσαν. 13. Ὁ μάντις τῷ θεῷ ἔθυσεν. 14. Ὁ μάντις τῷ θεῷ βοῦς ἑκατὸν τέθυκεν. 15. Παιδεύω τὰ τέκνα. 16. Ἐπαίδευον τὰ τέκνα. 17. Ἐπεπαιδεύκει τὰ ἑαυτοῦ τέκνα. 18. Ἀλέξανδρος Βαβυλῶνα κατέλυσεν. 19. Ἀλέξανδρος Βαβυλῶνα κατελελύκει. 20. Ὁ παῖς στολὴν γυναικείαν ἐνδύσει.

Ex. 78.—1. Two men are fighting. 2. Let us fight bravely for our country. 3. It is necessary that a son should obey his father. 4. Many good men are poor. 5. It is honourable to obey the laws of the country. 6. Do not welcome those of your friends who gratify you in bad things. 7. Let each go quietly along the middle of the road. 8. Let the citizens obey the laws. 9. My two brothers follow me. 10. If you are willing * to do well, work. 11. If you wish * (*should you wish*) to do well, work. 12. No one who lies escapes notice for a long time (*i.e.*, *no one lies for a long time without being found out*). 13. The Lacedæmonians used to go on their expeditions to the sound of flutes. 14. Would that all would consult without anger. 15. Two beautiful horses were driven into the city. 16. If you are poor, you have few friends.

Ex. 79.—1. Ἐκεῖνος πένεται καὶ ὀλίγους φίλους ἔχει. 2. Ἐβουλευέσθην. 3. Βούλει καλῶς πράττειν, ἐργάζου. 4. Ἐὰν βούλῃ καλῶς πράττειν ἐργάζου. 5. Καλῶς εἰργάζετο. 6. Ἐμάχοντο γενναίως. 7. Ἐμάχεσθε. 8. Ὦ στρατιῶται γενναίως μάχεσθε περὶ τῆς πατρίδος. 9. Καλόν ἐστι περὶ τῆς πατρίδος μάχεσθαι. 10. Σοὶ ἕπομαι. 11. Ἐμοὶ ἕπεται. 12. Ἐμοὶ ἕπονται. 13. Τῷ στρατηγῷ ἑπόμεθα. 14. Τῷ στρατεύματι εἱπόμεθα. 15. Τοῖς νόμοις, ὦ παῖδες, ἕπεσθε.

Ex. 80.—1. The robbers have been slain. 2. Two brothers have been educated by the same master. 3. The monarchy has been destroyed by the people. 4. Many temples to the gods have been built by the Athenians. 5. Let the door be shut at once. 6. Take care to have consulted well before acting (lit. *before the deed*). 7. The desire of self-government is implanted in all men. 8. Let the robbers be slain at once. 9. The enemy are said to have been shut up in the citadel. 10. Xenophon's two sons, Gryllus and Diodōrus, had been educated in Sparta.

Ex. 81.—1. Πεφόνευται. 2. Οἱ παῖδες πεφόνευνται. 3. Οἱ στρατιῶται ἐπεφόνευντο. 4. Κατακέκλεισται. 5. Κατακέκλεισθε. 6. Κατεκέκλεισθε. 7. Κατακεκλεισμένοι εἰσίν. 8. Ὣ δύο ἀνθρώπω κατεκεκλείσθην. 9. Οἱ βοῦς κατακεκλεῖσθαι λέγονται. 10. Εὖ πεπαίδευμαι. 11. Εὖ ἐπεπαίδευσο. 12. Εὖ πεπαίδευνται. 13. Κακῶς ἐπεπαιδεύμην. 14. Τὰ δένδρα εὖ πεφύτευνται. 15. Τὰ δένδρα κακῶς ἐπεφύτευτο.

ENGLISH LITERATURE.—VIII.

[*Continued from p.* 74.]

THE ELIZABETHAN PERIOD: PROSE.

MUCH of what we have said of the development of poetical literature in England during the Elizabethan age applies equally to the prose of the same period. We have, in common with almost every writer on the subject, treated the Elizabethan age as including not only the reign of the Queen herself, but also that of her successor. In prose literature, as in poetry, the great brilliancy of the period belongs to the later more than to the earlier portion of it. Most of the great writers who adorned it were either still unborn, or mere children, when Queen Elizabeth began her reign. And the contrast is striking between the scantiness in amount and meagreness in quality of the prose literature of the first years of her reign, and the variety and power of the close of the period of which we speak. A few of the writers whom we have thought it better to treat as belonging to the preceding age, such as Ascham, were still living at the time of the Queen's accession. Thus Ascham's "Schoolmaster," which we have already mentioned, though probably written before, was published in the reign of Elizabeth. But the prose literature of this earlier period has been generally described by Hallam, and its merits and defects sufficiently pointed out in a single sentence:—"We should search in vain for any elegance or eloquence in writing. Yet there is an increasing expertness and fluency; and the language insensibly rejecting obsolete forms, the manner of our writers is less uncouth, and their sense more pointed and perspicuous than before."

But in the later years of Elizabeth, not only was literature abundant, but literary taste was the fashion; and this led to one curious phenomenon which deforms a portion of the literature of the period, and had a very extensive and corrupting influence upon the taste of the Court, and hence of the nation. The style of writing known as ***Euphuism*** derived its name from the most conspicuous example of the style itself, the "Euphues" of Lyly. John Lyly (born about 1553), whom we shall have to mention again as a dramatist, was the author of a prose romance in two parts, containing the adventures of a young Athenian, first at Naples, described in the first part, "Euphues, the Anatomy of Wit," and secondly in England, described in the second part, "Euphues and his England." The style is affected and unnatural, made up of laboured antithesis, far-fetched and inappropriate illustrations, artificially inverted sentences—of everything which is most at war with ease, simplicity, and grace of language. The book would scarcely be worth noticing in the present day were it not for the great influence it exercised in its own time. It at once became a favourite at the Court of Elizabeth, everyone who aspired to a reputation for literary taste and culture imitated its absurdities in his conversation, and the taint of Euphuism is found among a very large part of the lesser writers of the period; while some of the greater, perhaps even Shakespeare himself, the greatest of them all, can hardly be said to have always escaped it. Shakespeare, in *Love's Labour's Lost*, through the lips of Holofernes, caricatures this affectation of style; and Scott, more broadly still, in the character of Sir Piercy Shafton, in the "Monastery."

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* The difference between εἰ βούλει and ἐὰν βούλῃ may be thus explained. Εἰ βούλει assumes that you are willing—*If you are willing, which I believe you to be*, and so should be translated *since*; ἐὰν βούλῃ makes no such assumption—*Should you be willing, about which I express no opinion either way.*

To a very different class belong the writings of Sir Philip Sidney. Sidney was perhaps the purest example of the highest type of character which that age produced; a type which combined the high courage, generosity, and adventurous devotion of the ages of chivalry with the learning, culture, and tolerance of a later day. We shall not speak here of his fame as a soldier, of his universal popularity, or of the general grief at his early death on the field of Zutphen in 1586. We have already had occasion to mention him as a poet, and as the friend and patron of poets, especially as the generous and faithful friend of Spenser. But in the history of literature Sir Philip Sidney's place depends mainly on his prose works, which are two in number—the "Arcadia" and the "Apology for Poesy." Both were first published after the death of the author. The "Countess of Pembroke's Arcadia," so called by the writer from his sister, to whom it is addressed, was written at Penshurst, and is a romance with much variety of incident, some conception of character, and, in parts, a good deal of power of depicting the gentler emotions, being in all these respects far superior to any prose work of fiction which had been produced in England previously, or for a long time afterwards. The "Apology for Poesy," or "Defence of Poetry," written soon after the "Arcadia," is a short essay on poetry (using poetry in a wide sense to include all works of mere imagination, whether in verse or in prose), its uses and pleasures, and the reasons why poets and poetry were not held in higher esteem. As a work of criticism this work is not, and does not profess to be, profound or systematic; but it is full of good sense and good taste, and there are probably few of Sidney's judgments which a critic of the nineteenth century would be inclined to reverse. But the great merit of Sidney's works consisted not so much in what he had to say, as in the mode in which he said it. His style combines clearness and simplicity with dignity and variety, to a degree quite unknown till then; and from the great popularity which his works obtained, especially the "Arcadia," there can be little doubt that he contributed more than any previous writer had done to the formation of a sound standard of taste in the matter of style. A few extracts from the "Apology for Poesy" will give some idea of Sidney's style of treatment and expression:—

> "I speak to show that it is not rhyming and versing that maketh a poet, no more than a long gown maketh an advocate, who, though he pleaded in armour, should be an advocate and no soldier. But it is that *feigning* notable images of virtue, vices, or what else, with that delightful teaching which must be the right describing note to know a poet by; although, indeed, the senate of poets have chosen verse as their fittest raiment, meaning, as in matter they passed all in all, so in manner to go beyond them all; not speaking (table-talk fashion, or like men in a dream) words as they chanceably fall from the mouth, but peising each syllable of each word in just proportion, according to the dignity of the subject."
>
> "Certainly even our Saviour could as well have given the moral common-places of uncharitableness and humbleness, as the divine narration of Dives and Lazarus; or of disobedience and mercy, as that heavenly discourse of the lost child and the gracious father; but that his through-searching wisdom knew the estate of Dives burning in hell, and of Lazarus being in Abraham's bosom, would more constantly (as it were) inhabit both the memory and the judgment. Truly, for myself, meseems I see before my eyes the lost child's disdainful prodigality turned to envy a swine's dinner; which by the learned divines are thought not historical acts, but instructing parables. For conclusion, I say the philosopher teacheth, but he teacheth obscurely, so as the learned only can understand him, that is to say, he teacheth them that are already taught; but the poet is the food for the tenderest stomachs, the poet is indeed the right popular philosopher, whereof Æsop's fables give good proof; whose pretty allegories, stealing under the formal tales of beasts, make many more beastly than beasts begin to hear the sound of virtue from these dumb speakers."

In a later part of the treatise, having gone through the various classes of poetry, and spoken eloquently on the value of each, he comes to the subject of lyric poetry:—

> "Is it the lyric that most displeaseth, who, with his tuned lyre and well-accorded voice, giveth praise, the reward of virtue, to virtuous acts, who gives moral precepts and natural problems, who sometimes raiseth up his voice to the height of the heavens in singing the lauds of the immortal God? Certainly I must confess my own barbarousness. I never heard the old song of Percy and Douglas that I found not my heart moved more than with a trumpet; and yet it is sung but by some blind crowder, with no rougher voice than

rude style; which being so evil apparelled in the dust and cobwebs of that uncivil age, what would it work trimmed in the gorgeous eloquence of Pindar?"

Sir Walter Raleigh resembled Sidney in the universality of his accomplishments, and in the brilliancy of his reputation. His adventures and successes as a courtier, an explorer, and a colonist, his long imprisonment, and his tragic end, belong rather to general history than to the history of literature. But in the history of literature Raleigh deserves a place, not only for his poems, which, though short and not very numerous, ought by no means to be forgotten; but far more, for his remarkable prose work, "A History of the World." The part of the work actually executed only carries the history down to the Second Macedonian War, and of course, even for the period of which it does treat, Raleigh's history has long ceased to be used as a text-book, or cited as an authority, as must be the case with any general history so early in date; but as an example of English prose writing it holds a very important place in our literature.

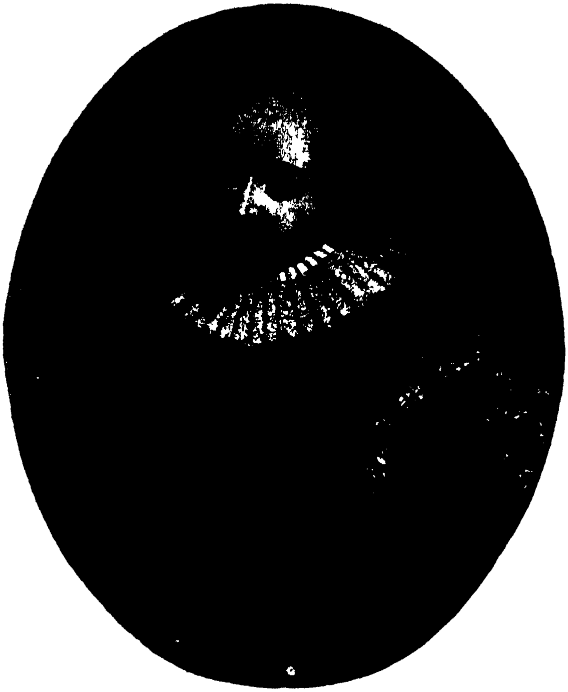
SIR WALTER RALEIGH. (*From a Portrait by Zucchero.*)

In remarkable contrast with the work of Raleigh stand the works of the laborious chroniclers, a series of whom wrote during the period of which we are now treating. To this class belong Stow, Holinshed, and Speed, of whom the former two wrote in the reign of Elizabeth, and the third in that of James I. Stow devoted himself mainly to the illustration of the history of the city of London; Holinshed and Speed to that of England generally.

Theology occupied a large space in the prose literature of this as well as of the preceding period; but the points mainly in controversy now were different from what they had been. The war between Protestantism and Catholicism was as keen as ever; but in the days of Elizabeth its battles were fought more often with the sword than with the pen. The controversies about which English theologians mainly employed themselves, in those works at least which have been proved to have a lasting interest, were those between Anglicans of various shades and the Puritan Nonconformists. Many of the theologians of this period were powerful writers; Bishop Andrews in particular was equally distinguished for learning and eloquence, and his sermons and treatises are still largely read and highly valued. But far the greatest writer in this department of literature was Hooker. Richard Hooker was born of very humble parentage, and educated at Oxford, where he early acquired an immense reputation for learning and ability. He was ultimately appointed Master of the Temple. His great work is the treatise on "The Laws of Ecclesiastical Polity," which is an elaborate defence of the position of the Church of England. The merits of the work, from a theological point of view, or the soundness of its philosophical and political doctrines, it would be quite beside the purpose of these lessons to discuss. But however men's estimates of the value of the "Ecclesiastical Polity" as a philosophical treatise may vary according to the changing phases of theological controversy from age to age, or the various stand-points of individual thinkers, this great work must always remain one of the most perfect examples of English prose style—the most perfect, perhaps, that could be selected from among controversial treatises.

But the most important publication of this era, in its influence upon the literary taste of the people, as well as in other and higher aspects, was that of the present authorised version of the Bible in 1611. We have already explained that the various versions, from that of Tyndall down to that of which we are now speaking, were not so many wholly independent versions, but that each was founded upon, and borrowed largely from, its predecessors, though at the same time each was something much more than a mere revision of that which went before. The consequence is that the language of James's Bible is not exactly the language commonly written or spoken in James's day, but rather that of a somewhat earlier period, and must, even in James's time, have had a slight air of antiquity in the ears of those who listened to it. Probably the very air of antiquity—not enough to obscure the meaning or grate harshly upon the ear, but enough to vary the tone of the language from that of every-day life—may have contributed then, as we think it undoubtedly does now, to give to the very words of the English Bible that power of reaching the mind and the affections, and imprinting themselves upon the memory of men and women of all ages and all classes, which they share with those of no other book, and which, according to general testimony, no other version of the Bible possesses in an equal degree

Among the writers of this age there is one who stands so completely alone that it is impossible to group him with any other. Robert Burton was a clergyman, and held benefices in several parts of England, as well as a vicarage in Oxford; but he spent the greater part of his life in Oxford, living a studious and laborious life among his books. His remarkable work, "The Anatomy of Melancholy," was published in 1621. This singular book is a collection of the most extensive and out-of-the-way learning, combined with much originality and humour. It was long one of the most popular of books, and furnished materials or suggestions to many subsequent writers, though it is now but little read.



FRANCIS BACON. (*From the Portrait by Van Somer.*)

We have reserved to the last the consideration of by far the greatest prose writer of this period, the greatest philosophical writer that England has ever produced. Francis Bacon was born in London in 1561. He was the son of Sir Nicholas Bacon, who held the office of Lord Keeper of the Great Seal under Queen Elizabeth. The future Chancellor was also nephew of the Lord Treasurer Burleigh. He therefore started in life under circumstances apparently very favourable to his advancement in the public service; but it is doubtful whether he derived much assistance from his relationship to Burleigh, the Lord Treasurer having, apparently, for some reason which we cannot perhaps now clearly determine, no very cordial feeling towards his nephew. He received his university education at Cambridge, and was afterwards sent abroad to gain the benefit of foreign travel. On his return from abroad, and after the death of his father, he selected the law as his profession. He was called to the bar at Gray's Inn, and entered upon the active exercise of his profession. He soon acquired a great reputation as a profound lawyer and a consummate advocate, and his professional practice became very large. Nor was his political career less successful. He was a partisan of the Earl of Essex, and received much valuable support from him, though in the hour of Essex's fall Bacon was found among his enemies. His advancement became rapid after Elizabeth's death and the accession of James I He took a prominent part in the debates of the House of Commons, showing himself generally a willing and obedient instrument of the Court party He became successively Solicitor-General, Attorney-General, and Lord Chancellor, with the titles of Baron Verulam and Viscount St. Albans The last-named high office Bacon filled from 1617 to 1621. But in the latter year, the contest between the Crown and the Commons running high, Bacon, as well as others, fell most justly a victim of popular indignation. Charges were made against him of corruption and receiving bribes in his judicial capacity. He was impeached at the bar of the House of Lords and unanimously convicted. He was sentenced to a fine of £40,000, and to imprisonment during the king's pleasure, together with various disabilities, such as from holding public office or sitting in Parliament. The substantial parts of this punishment—the fine and imprisonment—were soon remitted by the king; but Bacon's fall was irretrievable. He lived till 1626 in much embarrassment, and at last died of a fever, said to have been brought on by a chill received in the course of a supposed scientific experiment.

RALEIGH'S PRISON IN THE TOWER OF LONDON.

Any attempt at an elaborate examination of the philosophic value of Bacon's works, or to determine the place which he is entitled to fill in the ranks of science, would be out of place here. Such an attempt belongs more properly to a history of philosophy than to these introductory lessons in literature. Without entering upon any controverted questions, it is enough to say that whatever scientific achievements had been accomplished (and they were great), however soundly and boldly men had used induction as an instrument for the discovery of truth (and there were already men who had done so as surely and as boldly as any have done since), no one had ever examined and expounded the principles of philosophic inquiry as Bacon did. And he who teaches the true principles of any art is not the less entitled to praise because there have been those who practised the art not without success before its rules had ever been systematically expounded.

The great philosophical work which Bacon conceived and mapped out for himself was the "Instauratio Magna," which was intended to contain his whole system of philosophy. It was to consist of six books; but of the six only two were ever completed, nothing more than scanty fragments or specimens having been written of the remainder. The first part of the "Instauratio Magna" was published in English in 1605, under the title "Of the Proficience and Advancement of Learning." It was afterwards, in 1623, republished in Latin in an enlarged form, under the title "De Augmentis Scientiarum." This work consisted of an examination into the then state of scientific knowledge, a natural introduction to the exposition of a sounder method in philosophy than that which was still too much in use. The second part of the "Instauratio Magna" was published in Latin in 1620, under the title 'Novum Organum." In this book Bacon gives his exposition of the inductive method, the new instrument (as he calls it) of investigation, together with an exposure of those *idola*, false appearances or conceptions, which chiefly lead men astray in their pursuit of truth. Of the other contemplated books of the "Instauratio Magna" nothing more than fragments in any case were written.

In addition to the great work of which we have spoken, Bacon was the author of numerous smaller works, both English and Latin. His "History of the Reign of Henry VII." and his "Essays" are the most remarkable of those in English. The "Essays" were the most popular of his works during his life, as he himself says, "for that, as it seems, they come home to men's business and bosoms"; and they have remained so to this day. This is the volume which any student who has not the time or the inclination for a thorough study of Bacon's larger philosophical works, but who desires to obtain some understanding of his wonderful powers, ought to read most carefully. The "Essays" are not essays according to the modern usage of the word; they are not full and finished treatises on isolated points or branches of a subject. Bacon used the word "essay" in its original sense—an attempt; and his essays are short studies on great subjects—sketches, not finished pictures. But, like a perfect sketch, each essay contains the whole outline of a finished picture. Their leading characteristics are clearness and comprehensiveness of thought, unequalled conciseness of expression, and beauty and harmony of language. There is no book in the whole range of English literature which it is more incumbent on the student thoroughly to master.

COMMERCIAL CORRESPONDENCE.—III.

[*Continued from p.* 78.]

FRENCH, GERMAN, AND ENGLISH.

16.—FORM OF ADVICE OF A TRAVELLER'S VISIT.

Lyons, March 28*th*, 1891.

Messrs. Smith, Cook & Hyde, London.

Gentlemen.—We beg to inform you that our Mr. Robert Roche will wait upon you to submit to your inspection samples of our latest manufactures in Dresses and Shawls, Waistcoatings, Cravats, and Handkerchiefs.

Trusting soon to be favoured with a large order,
We remain, Gentlemen,
Your obedient Servants,
LECOUTEUR, GASPARD & CO.

Lyon, le 28 *mars.* 1891.

Messieurs Smith, Cook & Hyde, à Londres.

Messieurs,—Nous avons l'honneur de vous annoncer que notre M. Robert Roche se présentera chez vous pour vous soumettre les échantillons de toutes nos nouveautés pour robes, châles, étoffes pour gilets, cravates et foulards.

Dans l'espoir de recevoir bientôt une bonne commande,
Nous vous présentons, Messieurs,
nos salutations empressées,
LECOUTEUR, GASPARD & C^IE.

Lyon, 28 März, 1891.

Herren Smith, Cook & Hyde, London.

Wir erlauben uns Ihnen mitzutheilen, daß Herr Robert Roche ſich beehren wird Sie zu beſuchen, um Ihnen Muſter von unſeren neueſten Fabricaten in Kleidern und Shawls, Weſten, Cravatten und Tüchern zu unterbreiten.

In der Hoffnung bald mit einer belangreichen Order beehrt zu werden, zeichnen wir,
Hochachtungsvoll,
Lecouteur, Gaspard & Co.

17.—LETTER ADVISING DESPATCH OF GOODS AND ENCLOSING INVOICE.

London, April 10*th*, 1891.

Philip Teesdale, Esq., Dublin.

Dear Sir,—Enclosed please find invoice of Cotton Goods forwarded to-day in a case marked P T, No. 5.

The amount of this invoice
£450 please place to my credit.

Awaiting your further orders, to which my best attention shall always be given,
I remain, dear Sir,
Yours truly,
A. LONSDALE.

Londres, le 10 *avril*, 1891.

Monsieur Philip Teesdale, à Dublin.

Cher Monsieur,—Ci-joint j'ai le plaisir de vous remettre facture à des Cotonnades qui vous ont été expédiées ce jour dans une caisse marquée P T, N° 5.

Pour le montant de cette facture veuillez me reconnaître de £450.

Dans l'attente de vos ordres ultérieurs, qui auront tous mes soins,
Je vous présente, cher Monsieur,
Mes salutations sincères,
A. LONSDALE.

London, 10 April, 1891.

Herrn Philip Teesdale, Dublin.

Anbei wollen Sie Factura über Baumwollſtoffe finden, die Ihnen in einer Kiſte, markirt P T, No. 5, heute zugeſandt wurden. Den Facturenbetrag von £450 belieben Sie meinem Conto gutzubringen.

Ihren ferneren Orders, die ſtets meine vollſte Aufmerkſamkeit haben werden, ſehe ich gerne entgegen.
Hochachtungsvoll,
A. Lonsdale.

18.—LETTER ENCLOSING CHEQUE.

Dublin, April 12*th*, 1891.

A. Lonsdale, Esq., London.

Sir,—Your favour of the 10th instant is duly to hand, covering invoice of goods forwarded in case P T, No. 5, for which I beg to hand you cheque for £450, of which please acknowledge receipt by return of post.

By sending your new patterns for the coming season as early as possible, you will oblige, Sir,
Yours truly,
PHILIP TEESDALE.

Dublin, le 12 *avril*, 1891.

Monsieur A. Lonsdale, à Londres.

Monsieur,—J'ai bien reçu votre honorée du 10 avril, couvrant facture à des marchandise expédiées dans la caisse P T, N° 5, pour lesquelles je vous remets mon chèque de £450, dont veuillez m'accuser réception par retour du courrier.

Vous m'obligeriez beaucoup en m'envoyant le plus tôt possible vos nouveaux échantillons pour la saison prochaine.

Recevez, Monsieur, mes salutations sincères,

PHILIP TEESDALE.

Dublin, 12 April, 1891.

Herrn A. Lonsdale, London.

Ich empfing Ihr Geehrtes vom 10 c. mit Factura über geſandte Waren, Kiſte P T, No. 5, gegen welche ich Ihnen hiermit einen Cheque von £450 ſende, deſſen Empfang Sie mir gefälligſt umgehend anzeigen wollen.

Durch ſchnellſte Zuſendung Ihrer neuen Muſter für die kommende Saiſon werden Sie mich verbinden.

Hochachtungsvoll,

Philip Teesdale.

19.—LETTER REQUESTING FURTHER ORDERS.

Lyons, *December* 30*th*, 1891.

Messrs. Dufour & Co., Paris.

Gentlemen,—It is now more than three months since we had any orders from your firm; nevertheless, we are persuaded that the fault does not lie with us, or the manner in which we have executed your last.

We are more vexed than you at the rise in velvet, and we know that your sale must in consequence be hampered. If you, however, realise that throughout France and Italy cocoons have fetched from 6 fr. to 6 fr. 90 c. per kilogram—that is to say, 18 per cent. more than last year, and that consequently silk costs us 18 per cent. above last year's prices—you will see the necessity of our raising the prices of our velvet in proportion.

You will find in our parcel some samples of what we have in stock, and we subjoin our price list.

Our Mr. Marchand will be in Paris next Tuesday, and will have great pleasure in giving you further details.

We are, Gentlemen,

Truly yours,

JACQUES MARCHAND, BRIGAUD & Co.

Lyon, *le* 30 *décembre*, 1891.

Messieurs Dufour & C^{ie}, à Paris.

Messieurs,—Il y a plus de trois mois que nous n'avons reçu d'ordres de votre maison; nous ne pouvons, pourtant, imaginer que la manière dont nous vous avons traités dans le dernier envoi, ait pu diminuer la confiance que vous nous avez accordée.

Nous sommes plus fâchés que vous de l'élévation de prix que vont subir nos velours, et nous sentons bien que cela vous gênera pour la vente. Figurez-vous que les cocons se sont payés partout en France et en Italie de 6 fr. à 6 fr. 90 le kilogramme—c'est-à-dire, 18 pour cent plus cher que l'an dernier—les soieries de toute cette campagne vont donc nous coûter 18 pour cent de plus que l'an dernier, et il faut que nous augmentions nos velours en proportion.

Vous trouverez dans notre envoi quelques échantillons de ce que nous avons de disponible en magasin, et ci-joint notre note de prix.

Notre M. Marchand sera à Paris mardi prochain, et aura le plaisir de vous entretenir plus longuement de tous ces détails.

Agréez, Messieurs,

Nos saluts empressés,

JACQUES MARCHAND, BRIGAUD & C^{IE}.

Lyon, 30 December, 1891.

Herren Dufour & Co., Paris.

Wir haben ſeit mehr als drei Monaten keine Orders von Ihrer werthen Firma erhalten, nichts deſtoweniger ſind wir aber überzeugt, daß der Grund hierfür nicht in uns zu ſuchen iſt, oder in der Art und Weiſe, wie wir Ihre letzten Aufträge zur Ausführung gebracht haben.

Die Hauße in Sammet iſt uns unangenehmer als Ihnen, und wir verſtehen wohl, daß Ihnen Verkäufe dadurch erſchwert werden muſſen. Wenn Sie jedoch bedenken, daß Cocons in ganz Frankreich und Italien von fs. 6 bis 6.90 per Kilo erzielt haben—d.h. 18 Procent. über letztjährigen Preiſen—, und daß uns die Seide in Folge deſſen mehr als 18 Procent. über jenen Preiſen koſtet, ſo werden Sie die Nothwendigkeit der entſprechenden Preiserhöhung unſerer Sammtſtoffe begreifen.

Sie finden in unſerem Packet einige Muſter von fertiger Ware, und wir geben Ihnen hierbei unſere Preisliſte.

Unſer Herr Marchand wird am nächſten Dienſtag in Paris ſein, und ſich ein beſonderes Vergnügen daraus machen, Ihnen weitere Details zu geben.

Hochachtungsvoll,

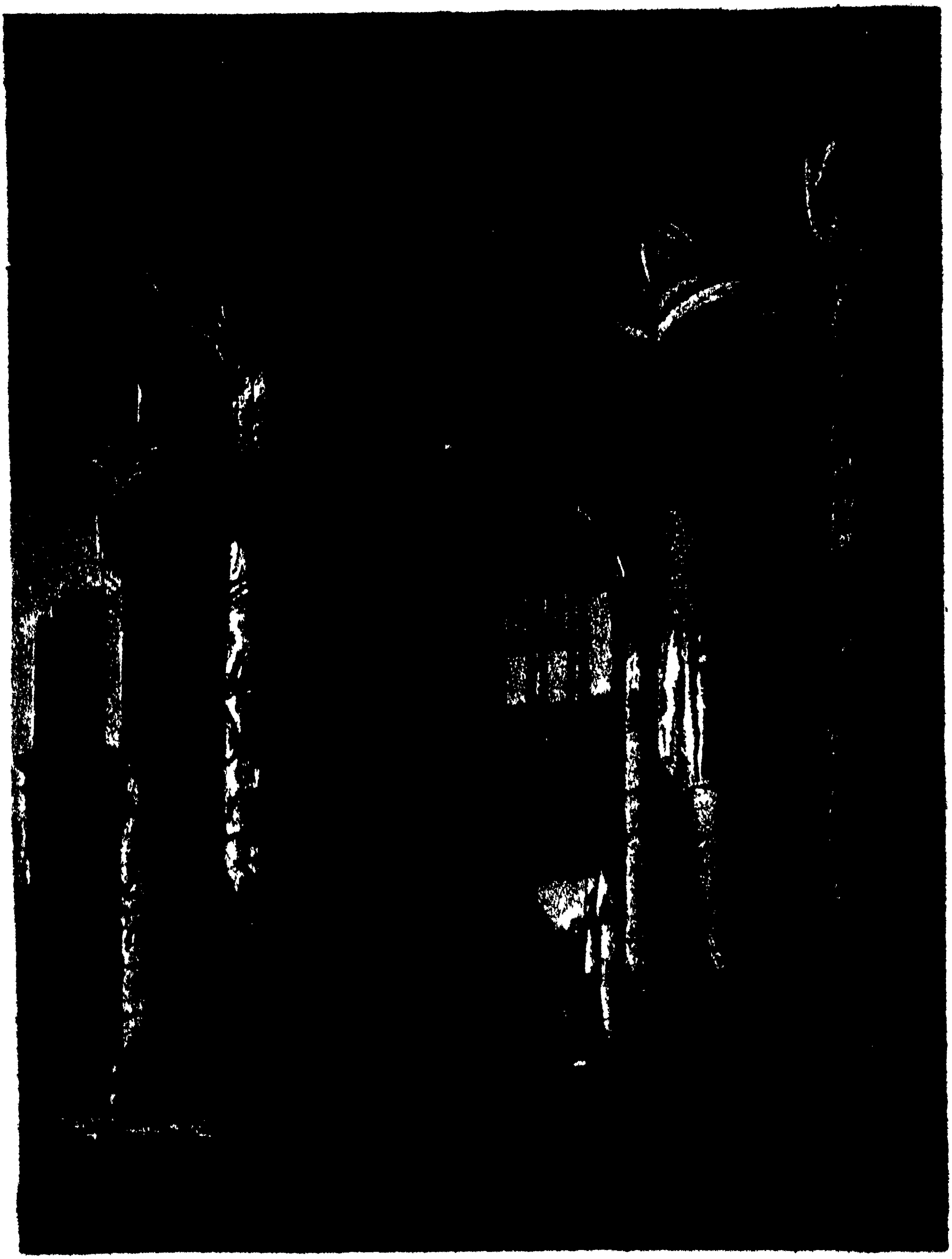
Jacques Marchand, Brigaud & Co.

20.—CIRCULAR LETTER OF CREDIT, ETC.

London, *March* 4*th*, 1891.

Gentlemen,—This circular letter of recommendation and credit will be remitted to you by James Muirhead, Esq., of Edinburgh, a gentleman for whom we claim from you a friendly reception, and we beg you to give him an opportunity of entering into business relations with the large landowners of your country. Mr. Muirhead belongs to one of the richest families in Scotland, and himself superintends his extensive and flourishing estates. As he intends looking over the land in the neighbourhood of your metropolis, you will oblige us by paying every attention in your power to his family, who, having accompanied him thus far, will remain a few weeks in your city during his short absence.

As to the funds which Mr. Muirhead will require



THE GREAT HALL, KARNAC

we beg to open a credit with you in his favour for the sum of £5,000 (five thousand pounds sterling), which you will please to pay, indorsing on this letter each of the sums he will have received to the full amount of his credit. Please add to the amount your commission and all other expenses, and draw on us for the whole sum at the best possible rate of exchange, and at the date customary in your town.

Assuring you that due honour will always meet the drafts for the payments you will make to James Muirhead, Esq., the receipts for which you will be kind enough to send us, we beg to thank you beforehand for the attentions you will show to this gentleman and his family.

We shall always have the greatest pleasure in rendering you similar or other services, and begging you to command the same at any time,

We are, Gentlemen,
Your obedient servants,
SPIELMANN & Co.

Messrs. N. N. at Berlin, Vienna, Trieste,
Venice, Rome, Naples.

Londres, le 4 mars, 1891.

Messieurs,

La présente lettre circulaire de recommandation et de crédit vous sera remise par James Muirhead, Esq., d'Édimbourg, auquel nous vous prions de vouloir bien faire un accueil obligeant, et lui procurer en même temps la possibilité de se mettre en relation d'affaires avec les grands propriétaires de votre pays. Mr. Muirhead appartient à une des plus riches familles de l'Écosse, dont les terres prospèrent sous sa direction. Vous nous obligerez infiniment, Messieurs, si vous pouvez aussi contribuer aux agréments d'un séjour de quelques semaines que la famille de notre recommandé fera dans votre capitale, tandis que Mr. Muirhead lui-même visitera les terres voisines de la métropole.

Quant aux fonds dont Mr. Muirhead aura besoin, nous l'accréditons chez vous pour une somme totale de £5,000 st. (nous disons cinq mille livres sterling), qu'il vous plaira de lui payer, en marquant sur le dos de cette lettre chacune des sommes qu'il aura touchées jusqu'à l'épuisement de son crédit. Vous voudrez bien chaque fois ajouter à ces paiements votre commission de banque et tous les autres frais, en vous remboursant sur nous au meilleur cours possible et à l'échéance qui conviendra aux usages de votre place.

En vous assurant, Messieurs, que le meilleur accueil sera toujours préparé à vos traites pour les paiements que vous ferez à Mr. James Muirhead, et dont vous nous enverrez les reçus, permettez-nous de vous exprimer d'avance nos plus vifs remerciments des attentions que vous aurez pour notre recommandé et sa famille.

Nous éprouverons toujours le plus grand plaisir à vous rendre le réciproque, ainsi que tout autre service qui dépendra de nous, et vous prions de disposer librement de notre ministère.

Agréez, Messieurs, l'assurance de la plus haute considération de

Vos obéissants serviteurs,
SPIELMANN & Cie.

Messieurs N. N. à Berlin, Vienne, Trieste,
Venise, Rome, Naples.

London, 4 März, 1891.

Dieſer Circular Empfehlungs- und Creditbrief wird Ihnen von Herrn James Muirhead, aus Edinburgh, präſentirt werden, welchem Sie einen freundlichen Empfang bereiten wollen, und wir bitten Sie, ihm Gelegenheit zu geben, mit den großen Landbeſitzern Ihrer Gegend in Geſchäftsverbindung zu treten. Herr Muirhead gehört einer der reichſten Familien Schottlands an, und überwacht perſönlich ſeine ausgedehnten blühenden Beſitzungen.

Da er beabſichtigt ſich das Land in der Nachbarſchaft Ihrer Metropole anzuſehen, ſo werden wir Ihnen für jede Aufmerkſamkeit erkenntlich ſein, welche Sie inzwiſchen ſeiner Familie erweiſen wollen, die während ſeiner kurzen Abweſenheit einige Wochen in Ihrer Stadt zubringen wird.

Betreffs der Summen deren Herr Muirhead bedürfen wird, ſo eröffnen wir ihm hiermit bei Ihnen einen Credit für £5,000 (ſage fünftauſend Pfund Sterling) die Sie gefälligſt auszahlen wollen, unter Eintragung, auf der Rückſeite dieſes Briefes, jedes von ihm entnommenen Betrages bis zur Geſammtſumme des Credits. Wir bitten Sie Ihre Commiſſion ſowie alle Auslagen dem betreffenden Betrage hinzuzufügen und ſich für den Gegenwerth zum günſtigſten Curſe, und zu dem in Ihrer Stadt gebräuchlichen Termin, auf uns zu erholen.

Wir garantiren Ihnen hiermit, daß Ihre gegen Zahlungen an Herrn James Muirhead gezogenen und von deſſen Quittungen begleiteten Tratten ſtets gebührenden Schutz finden werden, und danken wir Ihnen im Voraus für alle Dienſte welche Sie dieſem Herrn und ſeiner Familie erweiſen wollen. Es wird uns ſtets zum größten Vergnügen gereichen, Ihnen ähnliche oder andere Dienſte zu leiſten.

Hochachtungsvoll,
Spielmann & Co.

Herren N. N. zu Berlin, Wien, Trieſt,
Venedig, Rom, Neapel.

ARCHITECTURE—VI.

[*Continued from p. 83.*]

THE MAHOMETAN STYLE.

THE title "Mahometan" is selected here as including the specific terms given to the various phases of style, found in different countries, of the buildings erected for the practice of the tenets laid down by Mahomet in the Koran. It includes "Saracenic," the term given to the architecture of

Cairo and Syria; "Moorish," that by which the style as practised in Spain, Morocco, and Barbary is known; "Persian-Saracenic," in Persia; "Indo-Saracenic," in India; and "Turkish," in Constantinople and its environs.

Mahometan chronology dates from the year of the Hegira 622 A.D., when Mahomet was fifty-two or fifty-three years old. Within a century from that date the north of Africa, Spain, Syria, and Persia had all been conquered or converted to the faith. In India its influence was not felt till the beginning of the thirteenth century, and the last province acquired was that now known as Turkey, with Constantinople as its capital, which was subdued and taken by the Turks in the middle of the fifteenth century, from forty to fifty years before the expulsion of the Moors from Spain.

The Arabs, the original founders of the faith, had no architecture of their own, but when they came among the building races, it was natural that they should at first take possession of those chief monuments of the countries they had subdued, and adapt them to their own religion. In course of time there would seem to have arisen that natural desire for architectural magnificence which is inherent in mankind, but having no architects or builders of their own, they employed the natives of the country (even although they might be Christians) to build for them. In Egypt all the early mosques are said to have been built by Coptic Christians; in Syria architects were brought from Byzantium; and even in India the natives of the various parts of the country were employed by them—the only prescription being that the new buildings should be in accordance with the requirements of the faith and of its tenets; and, that they should contain certain features, the most important of which was the kiblah or niche, which indicated to the faithful the exact position of Mecca, towards which every good Mahometan was required to turn when engaged in his religious observances.

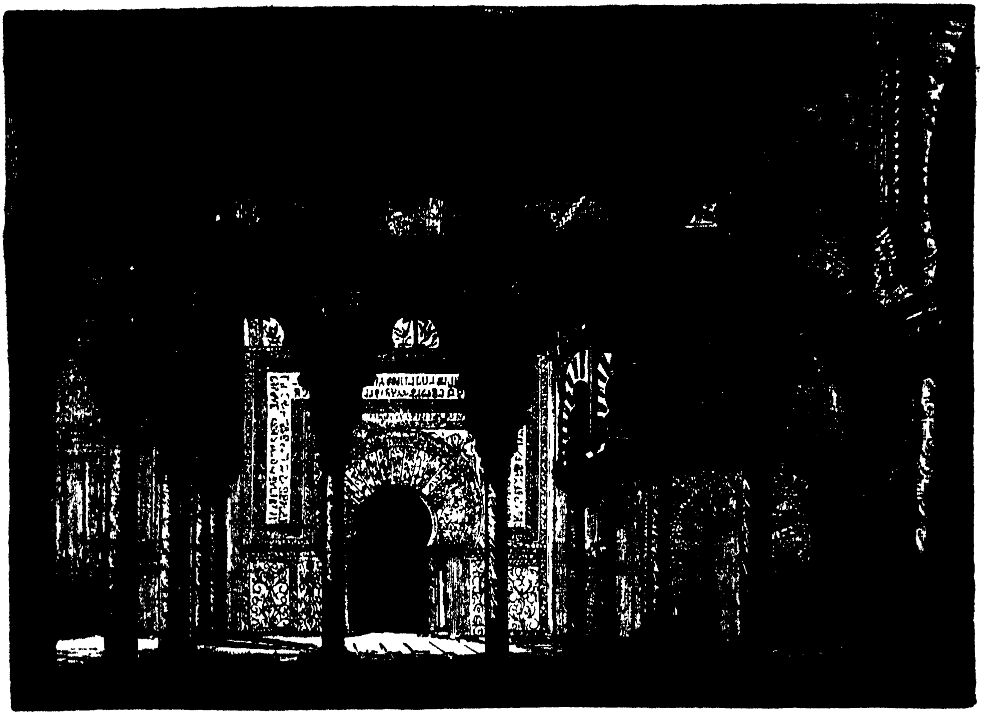


Fig. 20.—The Mosque of Cordova.

It follows naturally from this, that by employing native workmen, they accepted, at all events at first, the style of the country they had conquered. The requirements of the religion were such, however, that a new type of plan was soon evolved. The first would be (*a*) the enclosure of a large court by walls—in one of these (viz., that wall which was built at right angles to a line drawn to Mecca) was placed the kiblah or niche before referred to; (*b*) the provision of some suitable covering, called the prayer chamber, to protect the worshippers; this was obtained by carrying a roof on a series of arcades carried on columns, and forming a series of aisles all running at right angles to the Mecca wall; (*c*) arcades or covered approaches round the three sides of the court; (*d*) a fountain for ablution in the centre of the same.

These constituted the simple elements of the buildings required. In their decoration, however, they were limited by certain restrictions of their religion, which forbade the imitation of any natural objects, whether human, animal, or vegetable, and this soon led to the creation and development of new forms of ornament hitherto unknown. The first consisted of geometrical patterns of infinite variety (for the Arabs were great geometricians); the second of conventional flowing ornament, which, though based on the principles of nature, as regards its growth, never imitated it; and the third, a class of ornament which consists of the imitation of constructional features used, however, purely in a decorative sense; this, we have already pointed out, exists more or less in all styles. The Mahometans would seem to have carried it farther than any other builders, owing probably to the limitation imposed on them in not being allowed to copy nature.

In those buildings which were taken over for their purposes, such as the ancient church of St. John at Damascus, the church of St. Sophia at Constantinople, and some of the Jaina temples in India, they had to convert them as they best could. The earliest examples known of mosques specially built for the purpose are the mosque of Amrou in Old Cairo and the mosque of Kairwan in Barbary. In both these cases they took possession of the materials, however, of more ancient buildings, consisting chiefly of columns and their capitals, of Roman, and in Cairo of Roman and Egyptian work, and used them up in their new constructions.

The mosque of Amrou or Omar in Old Cairo, which was founded in 642 A.D., consists of a court 360 feet by 357 feet, with the Mecca wall facing south-east. The prayer chamber consists of twenty-two aisles, of arcades carried on columns, six of them to each row. On the north-east side there are round the court four aisles; on the south-west three; and on the north-west (in which is the entrance porch) one; the fountain no longer exists. All the arches are slightly pointed; they are carried on ancient columns with capitals and bases, and the arches are tied in at their springing, just above the capital, with beams of wood to resist the thrust. This mosque was enlarged and partially rebuilt in 691 A.D., so that it is not certain that all the features described belong to the earliest mosque.

The mosque of Kairwan was founded by the Emir Akbar in 675 A.D. It is 427 feet long and 225 feet broad. The prayer chamber consists of seventeen aisles, in each of which are seven bays or arches. It is much deeper, therefore, but not so wide as the mosque of Amrou. The central aisle facing the chief niche is wider; double aisles are carried round the court, in which there still exists the fountain. The arches of this mosque are circular-headed and horseshoe, that is to say, the curve of the semicircular arch above the springing is continued below the springing till it meets the projecting capital.

The mosque of Cordova (Fig. 20) was built in imitation of that of Kairwan in 786–790 A.D., having eleven aisles with twenty-one bays each for a prayer chamber; here also the columns and capitals were taken from earlier buildings. To this early part El Hakim added, in 962 A.D., twelve more bays, retaining, therefore, the same width, but doubling the depth of the prayer chamber. Later on, in 985, El Mansour increased the width by adding eight more aisles, making nineteen aisles altogether, with a depth of thirty-three bays; so that, with the court in front, the mosque now measures 430 feet by 377 feet, equal to 162,110 square feet superficial; larger than any cathedral, except St. Peter's at Rome. The height, however, is only 30 feet; even for that dimension the columns used were too short, so that, to obtain lightness in the arcade, a small arch was thrown from pier to pier above the lower arch. In the more elaborate parts of the prayer chamber, intersecting cusped arches were also added, which makes this mosque one of the most beautifully elaborated specimens of Moorish work. Later on in the Alhambra they copied as a decorative feature the intersecting constructional cusped arches of this mosque (Fig. 21). All the arches are horseshoe, and many of them cusped.

The mosque of Ibn Touloun, Cairo, 877 A.D., was constructed entirely with new materials from the designs of a Coptic architect. Its plan is similar to the mosque of Amrou, except that the aisles run parallel to, and not at right angles to, the Mecca wall. It is built in brick covered with stucco, highly decorated with Coptic inscriptions and ornament. The arches are all pointed—the earliest instance of their employment above ground. [N.B.—The pointed arch is found in the drains under the palace of Nimroud.]

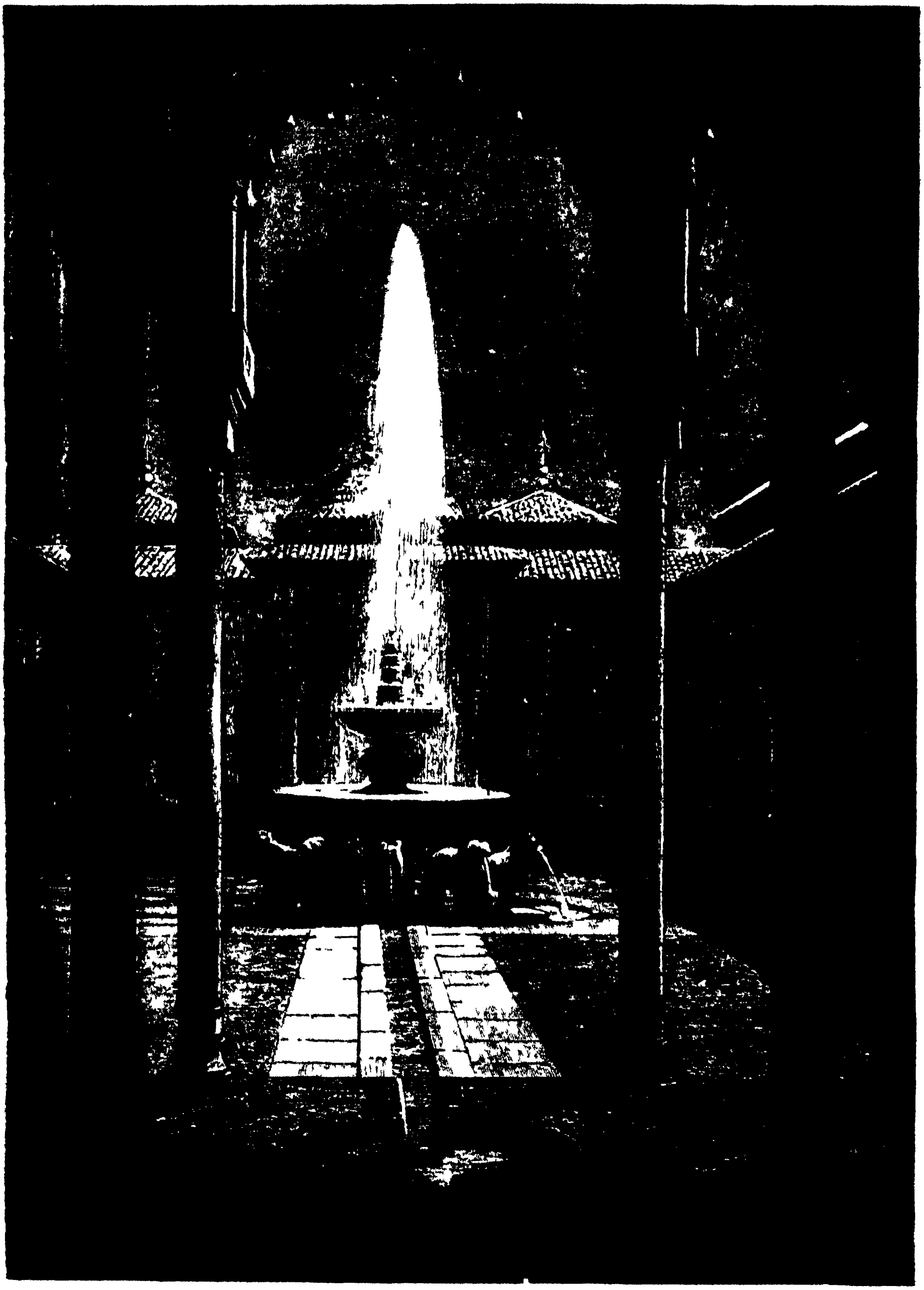


Fig. 21.—The Court of Lions in the Alhambra.

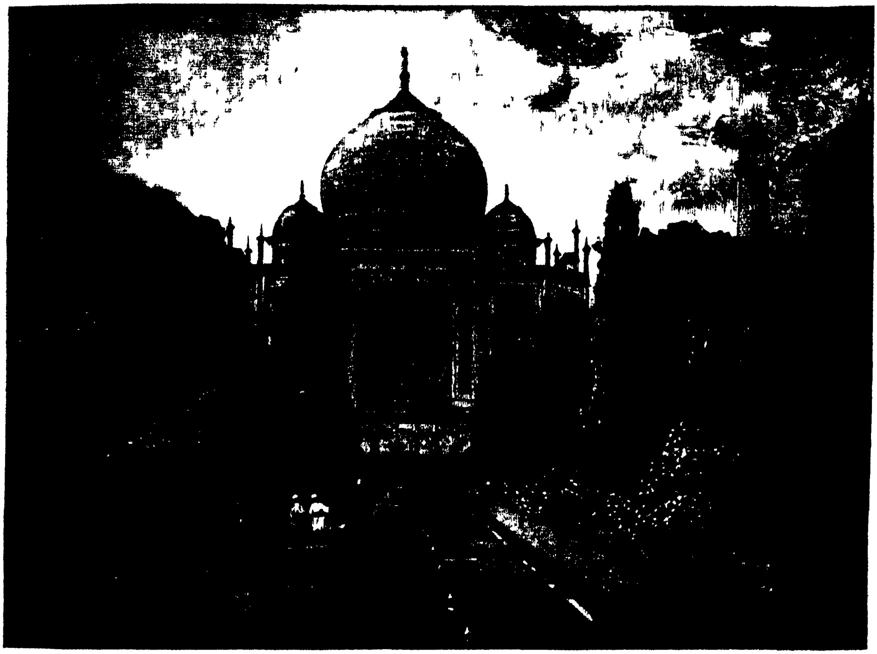


Fig 22.—The Taje Mehal.

The mosque of Sultan Hassan in Cairo, 1356 A.D., is a variation from the preceding. The prayer chamber consists of a huge recess or transept 69 feet wide, 90 feet deep, and 80 feet to crown of arch. It is covered with an immense pointed barred vault; on the three other sides of the central court are other transepts of less dimensions.

The portal or entrance to this mosque is 80 feet high, and leads to a vestibule crowned by a dome carried on what are known as stalactite pendentives, —the term stalactite being given to certain features of a constructional origin, employed decoratively throughout Mahometan building, the most elaborate being those of the halls in the Alhambra.

In the great mosque at Mecca the prayer chamber surrounds the court in which is placed the Kaaba or holy stone tower, towards which the Mahometan turns to pray.

In Syria the principal mosques are that at Damascus already referred to, the so-called mosque of Omar, which is known to the Mahometans as the Dome of the Rock—an octagonal building of great beauty, which was the rock from which Mahomet is recorded to have ascended into heaven; and the mosque of El-Aksa, the earliest portion of which was built by Christian architects for the Moslems, and is not quite in accordance with the usual plan.

In the mosques of Egypt and Syria there is a feature—the dome—to which we have not alluded, and which, though originally restricted to the covering of tombs, was afterwards introduced so frequently into mosques as virtually to become one of their characteristic features. These domes are, as a rule, built in stone, and covered with the most beautiful decoration, that which is called arabesque, consisting of geometrical figures interlaced with flowing conventional ornament. With the domes must also be mentioned the minarets (Fig 23), which are square towers surmounted with two or three storeys of octagonal lanterns, each smaller than the other, so as to leave a passage round, from which the muezzin or call to prayer is cried by the officials of the mosque.

In Persia, the earliest mosque existing, at Tabrees (1204–1211), resembles more a Byzantine church in plan, and it is not till near the close of the sixteenth century that we find in the great mosque at Ispahan a similarity of arrangement to that already described at Cairo and in Kairwan At this period, however, the style had become so far developed that the prayer chamber had become a sumptuous hall, surmounted by a dome and flanked by other halls roofed with a series of small cupolas. The domes in Persian as well as in Indian mosques have a peculiar bulbous form which is not found in the earlier types of Cairene work. The great glory of the Persian mosques is the magnificent wall decoration of glazed tiles with which they are covered, and which, by their brilliance and beauty of colour, have entranced all observers. A similar decoration is found on the walls of the Dome of the Rock (mosque of Omar) at Jerusalem, making it, with its interior decoration of marble, one of the gems of architectural art.

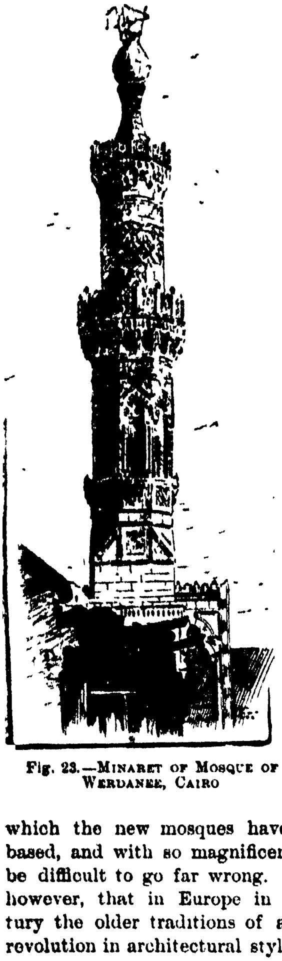


Fig. 23.—Minaret of Mosque of Werdanek, Cairo

In Turkey the church of St. Sophia has been the model on which the new mosques have had their designs based, and with so magnificent a model it would be difficult to go far wrong. When we consider, however, that in Europe in the sixteenth century the older traditions of art were lost, and a revolution in architectural style was taking place, it is surprising to find in the Suleimanie mosque, built 1550-1558, a building so fine in its proportions, and possessing so magnificent an interior as to be second only to St. Sophia's. In these new mosques the prayer chamber is virtually the mosque itself, with an atrium or court containing a fountain, and this type is followed in other Turkish mosques.

The Mahometan style in India possesses a greater variety than in any other country, owing to the occupation by the Moslem conquerors of the earlier buildings existing, which they altered or added to, to suit their own requirements. The great mosque at Delhi, for instance, is partially Hindu and partially Saracenic, and the same is found in the mosque at Ajmir; the walls and arched openings belong to the latter, the pillars to the former, the plan in both cases following the typical arrangement of the mosque of Amrou in Old Cairo. The most perfect mosque of its kind, and one in which the earlier forms have become thoroughly engrafted into the Indo-Saracenic style, is the Pearl mosque at Agra, built in white marble. The principal differences which we have to note in Indo-Saracenic work are its far greater solidity, owing probably to the influence of the earlier Indian work; a higher development of design and increased grandeur in the entrance gateways to the mosque, which at Futteypore-Sikri and at Jaunpore constitute features of greater size and magnificence than any found elsewhere; and lastly, the increased value attached apparently to the erection of sumptuous tombs, the Taje Mehal at Agra (Fig. 22) being the most magnificent mausoleum in respect of size, conception, and richness of material (marble inlaid with precious stones) ever erected.

POLITICAL ECONOMY.—II.

[*Continued from p.* 87.]

MONEY.—CAPITAL.

VALUE when expressed in money is called price. What then is money?

Omitting, for the present, *paper money*—which it will be clear on a moment's reflection is only valuable because it is supposed to represent so much coin—and *token money, i.e.*, shillings and pence (for reasons which will be clear hereafter), let us consider gold coinage, or the silver coinage of those countries where silver, not gold, is a standard.

Travellers in uncivilised countries usually carry with them something the natives are likely to want, and to be ready to take in exchange for food; such as knives or cotton cloth, or strings of ornamental beads. Now if (as sometimes happens) the natives have more of these things than they want, the traveller is in a difficulty. In early times, when neighbouring tribes lived very much alike and produced few things, and each produced much the same things, this difficulty must often have arisen. But there has occasionally been some kind of thing that everybody is likely to want, and for which everyone will exchange something. Even in quite civilised times this has happened; thus in Virginia in the last century, when there was a scarcity of coin, small quantities of goods were often exchanged for tobacco. Savages have often thought that some kind of shell or ornament brought luck or was in some way sacred, and have been ready to take any number in exchange for goods. When the Pilgrim Fathers settled in Massachusetts they found that on the beaches were shells highly valued by the Indians. Strings of these shells, called wampum, were thus readily accepted by the Indians in exchange for furs; and for more than a century the chief thing the Indians took for their furs was wampum, which was measured in strings of a certain uniform number of shells. Now very early in history the same sort of feeling seems to have existed about gold and silver Everyone was glad to possess bits of them, partly for their beauty, partly, perhaps, because they looked as if they were somehow connected with the sun and moon, which were worshipped as gods, and so their possession might bring good luck And as everyone desired them, everyone was glad to exchange goods for them; so they became the goods most commonly exchanged. Before they were plentiful, cattle had often been exchanged for goods; for in an early state of society, when pasture land is plentiful, a few more cattle are no more expense to feed, and everyone is proud to have more than his neighbours if he can. But gold and silver possessed great advantages over cattle they were portable, they were easily divided, they did not perish like cattle, one piece was as good as another piece of the same size and fineness They seem then to have been generally adopted in very early times as *circulating mediums*, not deliberately, but gradually and half-consciously At first they were exchanged in bars, with a stamp to show that they were of a certain purity; later on, to prevent fraud by clipping or scraping, they were cut into coins, rounded, and stamped on both sides

But it must always be remembered that *coin is still a commodity*. Even now if we take French gold coin to a money changer's, he will talk about "buying" the coin It is a peculiar kind of wealth, with the special use that it ensures command of a definite amount of commodities as no other kind of wealth does. By the invention of gold and silver coin we can, as it were, store up for future use the purchasing power which is value with the certainty that we can use it when we want to. We can, of course, exchange our other goods, but we must wait till we find someone who both wants them and has what we want, which may be a long time. Even then they may be damaged, and their purchasing power is quite uncertain By the use of money we do each exchange of goods for goods in two parts, very often separated by a long interval of time.

Money then (with certain exceptions referred to above) is a commodity selected by the general consent of society to effect exchanges in, originally because everyone prized it for its own sake, now because it has obvious advantages over any other commodity which might be used for the purpose. It is easily divisible, very durable, very portable, the coins of the same size and weight can be made absolutely uniform in value; and it fluctuates far less—except when we compare periods a century or two apart—in its value, or purchasing power over goods, than any other kind of goods does. It is thus a *medium of exchange*, a *measure or standard of value*, and a *store of purchasing power*.

In all countries, to secure that the coin shall be what it professes to be, Government has undertaken its manufacture, and declared that certain kinds of coin must be used, if the creditor demands it, in effecting a payment. But this is only to protect the creditor from being cheated. Except when the coinage is not what it professes to be, no part of the value of a coin is derived from the Government stamp—except so far as the purity and genuineness are thereby guaranteed. But in many countries coins of other countries circulate quite as freely as the coin of the country. Thus English sovereigns are said to be almost the only gold seen in Portugal. In some great commercial cities in the last century so much foreign coin was in circulation that payments were often made in half a dozen different sorts. The first bank at Amsterdam was founded expressly to save the merchants the trouble of calculating how much they had received. They took their various coins there, the values of the coins were reduced to a common denominator, and the merchants credited with the value of the result, expressed in the terms of a currency called "bank money."

We must guard ourselves against exaggerating the importance of money, great though it is. As a matter of fact in the large wholesale traffic of modern times, still more in trade between nations, not the half of the hundredth part is conducted with actual coin. Bills and cheques (as we shall see by-and-by) have virtually changed wholesale trade into barter again. The over-estimation of the importance of money led all the statesmen of Europe in the seventeenth and eighteenth centuries into the mistaken financial policy called the *mercantile system*.

They did not exactly believe (as it is sometimes said) that money alone was wealth, but they acted as if they did. In the then condition of Europe wars were very likely to break out, and they thought that each country ought to be prepared, first, by manufacturing for itself as far as possible; next by getting as much gold and silver as possible into the country and keeping it there. This was done by putting high duties on imports—because, it was thought, if goods are brought from abroad coin will go out of the country—and offering various inducements to merchants to export goods, so that the coin paid for them should come in. Then, with plenty of coin in the country, we shall (they argued) be able to pay for what we want readily if a war breaks out. Adam Smith exposed the weakness of this argument in a way we shall describe under Foreign Trade; and showed that the country would really become rich and powerful faster if the citizens were allowed to make and sell as they pleased, or at least with as little restriction as possible.

We have given much space to *value* and *price* and *money* because political economy is primarily the science of exchanges. Its central notion is value. A commodity is not wealth unless it has value. Wealth, however, is almost always produced by labour, though its value may not stand in any discernible relation to that labour.

Political economists usually enumerate the conditions of the production of the wealth as three—land, labour, and capital. This enumeration is not very satisfactory scientifically, dating as it does from a time when force or energy was hardly recognised as a real thing. "Land" in it includes all forces of nature before human effort has done anything to them, and "capital" those forces after that event. "Labour," too, is of two kinds: mere muscular effort, such as lifting a box or pulling a rope, and intelligent direction of force by tools and machinery or otherwise. As civilisation advances mere muscular effort is replaced by machinery, with very great benefit to the world at large, though often with inconvenience and suffering to the particular people concerned. It is truer to say (as Mill did) that the requisites of production are labour and natural agents. But as a rough preliminary division we may preserve the threefold division into land, labour, and capital. It has a reason in the history of the science, viz.: that in England and France, where political economy was first studied, the product in the last century was on the whole divided between three great classes—landowners, labourers, and capitalists. As their shares of the product were found to depend on different sets of causes, it was natural to take separately what they contributed to the process of production.

"Labour" is divided by economists into productive and unproductive. "Productive" labour produces utilities fixed and embodied in material objects. Thus a tailor who makes a coat, an agricultural labourer who sows or reaps corn, or feeds cattle, is a productive labourer. So all labour of transport counts as productive labour, because, according to Mill, "it confers on goods the utility of being in the place where they are wanted."

The exact line between productive and unproductive labour is rather hard to draw, and many rather silly things have been said about the "stigma" cast on labour by describing it as unproductive. It is forgotten that political economy uses the term in a sense of its own. "Production is not the sole aim of human existence," as Mill truly remarks; and the highest and most useful labour possible, the labour of the great religious or moral teacher, of the philanthropist, of the missionary, is only indirectly productive—if it is productive at all—in the special sense of political economy. It has been proposed to make an intermediate division—the indirectly productive—to include the labour of the schoolmaster for instance, because in most if not all trades men are better workmen if they have had a good general education But it is very hard to draw the line. Some sort of amusement is necessary if a workman is to be efficient, and so the people who amuse him might be called "indirectly productive labourers." But is the ticket-taker at a music-hall an indirectly productive labourer? Yet he is part of the establishment.

The fact is, any number of idle discussions may be raised about these preliminary notions. If we were going to deduce our conclusions without dealing with the facts, it would be very important to make our definitions precise at first. As we only deduce conclusions to verify them by comparing them with the facts, very precise definitions do not matter; we can wait and see if difficulties arise. By convention productive labour includes the labour of protection—the soldier, the magistrate, the policeman—who prevent wealth from being destroyed, and ensure the security necessary to production.

Of "land," as understood by the political economist, we need only say that it includes agricultural land, building-sites, mines, fisheries, water-power, and generally every source of wealth *in nature* apart from the labour expended to make it useful. It is generally (for simplicity) assumed that it is owned in separate lots by individuals, which is true on the whole of the most advanced countries in the present and the last century, but is very far from being true of all times or countries.

Labour works on land with capital, or on the products of land, which are part of capital, with other capital, and so confers on material objects fresh capacities of satisfying desire.

Capital is defined by the political economist as wealth set aside to assist in the production of future wealth. Sometimes, but less accurately, he takes it in the popular sense, "that part of a man's possessions which he expects to afford him a revenue." Furniture, for instance, is not capital in the second sense, except to a person who lets furnished lodgings; in the first sense it never is capital at all. The cabinet-maker, it may be said, produces wealth for himself by selling it. But he does not add to the general stock of wealth by selling it, but by making it. The addition to his own stock of wealth which arises from his selling it is a case of mere transfer as regards the sum total of existing wealth. So a horse in a circus is "capital" in the second sense, not in the first. His owner by exhibiting him transfers wealth, in the form of coin, from other peoples' pockets to his own. But a horse employed on a farm, which draws a reaping-machine or takes goods to market, is capital in the first sense. Economists sometimes make further refinements by speaking of "personal capital," *i.e.*, abilities, but in the sense in which we have defined wealth, these are not wealth and cannot be capital.

Capital is divided by economists into "fixed" and "circulating" The use of all capital is to be consumed. In being converted into fresh wealth it perishes as capital. But some perishes as capital at once—coal, raw material, the food and clothing consumed by productive labourers, though as a matter of convenience an equivalent of this food and clothing is usually given them as money wages; all this is called circulating capital. Some only wears out gradually—machinery and tools; this is called fixed capital. As society progresses the proportion of fixed capital tends to increase. More machinery, and of a more elaborate and expensive kind, is introduced instead of hand labour, and this increases the aggregate of production in the long run.

Now capital is clearly the result of saving, and an increase of capital tends to increase production. Moreover, without capital production is impossible. The more saving there is then—not *hoarding*, but application of wealth as capital—the more production there will be, and as every increase of production must eventually tend to leave people free to have more wants and to try to make more things to satisfy them, the more employment there will be.

Hence we can easily see the fallacy of the doctrine that expenditure on things which are not capital is "good for trade" as a whole. It is good for certain traders and for the makers of the things. But, were the money spent on—that is, exchanged for—things that can be converted into fresh wealth, or used to produce it, the wealth now consumed and done with would be consumed and come back again with a surplus. The present producers of the things which are not capital, *i.e.*, luxuries, would have to turn to the production of things that are capital, and with more capital there would be more and ever-increasing employment.

In one way indeed, but quite an indirect one, expenditure on luxuries *is* good for trade. The more wants people have, the harder they will work to satisfy them, and so the more wealth there will be in the world, and the more wealth there is, the more people on the whole get a share of it. Wealth has always a tendency to be diffused, to be partly exchanged for services or goods to satisfy fresh wants. The large fortunes of individuals grow, but they grow not by being hoarded but by being spent, by being consumed by the owners, or by other people to whom the owners lend them, in such a way that they come back with an increase.

APPLIED MECHANICS.—X.

[*Continued from p.* 91.]

USEFUL HORSE-POWER—THE PRACTICAL MEASUREMENT OF ENERGY AND POWER BY MEANS OF DYNAMOMETERS—DYNAMOMETERS OR WORK-MEASURING MACHINES—NUMERICAL EXAMPLES.

In the last lesson we explained pretty fully how the energy given by the steam to the piston of a steam or other heat engine, in a given interval of time, could be measured. There are other machines, as well as engines, in which a record of work done can be automatically traced; but in the vast majority of cases the work must be measured in a different way. Suppose, too, that we know the indicated horse-power of an engine, the power *actually given out* by the engine is less than this and is often of far more importance; this useful

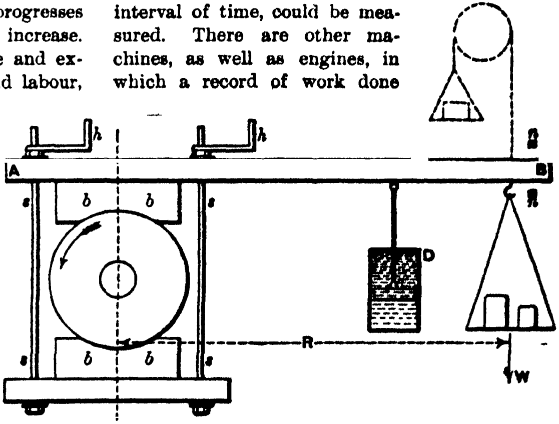


Fig. 59.

horse-power being usually measured by means of an instrument called a "dynamometer"—the name, however, scarcely indicating the real purpose of the apparatus. In these days, when *efficiency* is of so much importance, it is of the greatest consequence that the student should be familiar at least with a few leading forms of apparatus for this purpose and with the principles governing their action; for the question of the efficiency of any machine involves the measurement both of the work given to the machine and of the work given out by it.

DYNAMOMETERS OR WORK-MEASURING MACHINES.

A "dynamometer," as the name implies, is a "measurer of force," and the older forms of this apparatus were somewhat similar to our spring-balance. Modern dynamometers *measurers of energy*, and may be divided into two classes: *absorption* and *transmission* dynamometers; the former wasting the energy by friction whilst measuring it, the latter transmitting it without much waste. If a record of the time during which a given amount of energy is wasted or transmitted be kept, the instrument may be used to measure power, and it is to this purpose that most modern dynamometers are applied.

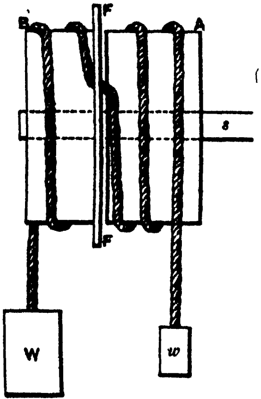


Fig. 60.

ABSORPTION DYNAMOMETERS.

The following rule will give the power *absorbed* by any absorption dynamometer in which the energy is wasted by the friction of a brake-block or strap on a pulley, viz.:—The algebraic sum of the moments of all the externally applied forces, taken about the centre of the brake-pulley and measured in pound-feet, multiplied by the angular velocity of that pulley in radians per minute, and divided by 33,000, gives the horse-power.

The Prony Brake.—One of the best known and most widely used of absorption dynamometers is the Prony brake. It was invented about the year 1820 by Piobert and Fardy, but improved and brought into successful use by Prony. There are many modifications of it in use, but the form shown in Fig. 59 will best illustrate the characteristic features of the instrument. It consists of a beam A B to which one of the brake-blocks *b b* is fastened, the other being fastened to a similar but shorter beam, and both pressed against the rim of the brake-pulley (which should be strong and truly cylindrical, and which rotates as shown by the arrow, being driven by the motor to be tested) by the screws *s s*, which can be tightened during the test till the beam just floats in the horizontal position and midway between the two stops *n n*. In this position the moment of the total friction between the brake-blocks and pulley is just balanced by the moment of the weight W, the beam itself being counterpoised by a weight shown in dotted lines. The moment of the weight W is W × R, hence if W is in pounds and R in feet, the horse-power absorbed is given by the rule,

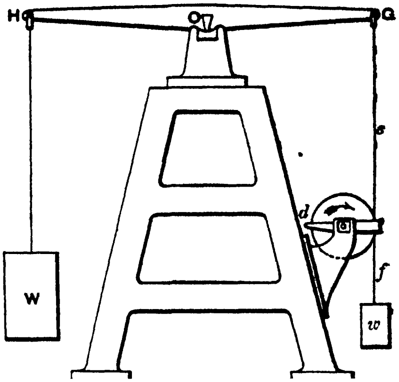


Fig. 61.

$$\mathrm{HP} = \frac{W \times R \times 2\pi n}{33000},$$

where *n* is the number of revolutions the brake-pulley makes per minute. The dash-pot D is attached to a wall or some separate support, and is filled with oil or other fluid, its object being to still the vibrations of the beam A B.

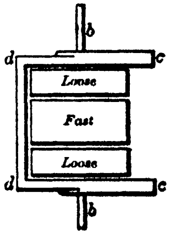


Fig. 62.

Carpentier's Dynamometer.—Ingenious methods have been adopted in order to make a dynamometer automatically adjust itself to variations in the coefficient of friction between the rubbing surfaces. Among these, that adopted by M. Carpentier (Fig. 60) is noteworthy. The shaft S, conveying the power to be measured, carries two pulleys, A being fast and B loose on the shaft. The pulley B has a flange F, in which is fastened the centre of a rope which is coiled round the two pulleys in opposite directions as shown, and which bears two unequal weights W and *w*. The direction of rotation is such as to lift the larger weight if the rope does not slip on the pulley A. If an accidental increase of friction *does* take place the weight W is lifted, and the amount of lapping of the belt on A, and hence the total friction, are diminished; so that there is always just sufficient rope on A to cause a steady waste of all the energy supplied. The weights W and *w* are carefully adjusted, so that the automatic adjustment will only have to compensate for *small* changes of friction or load.

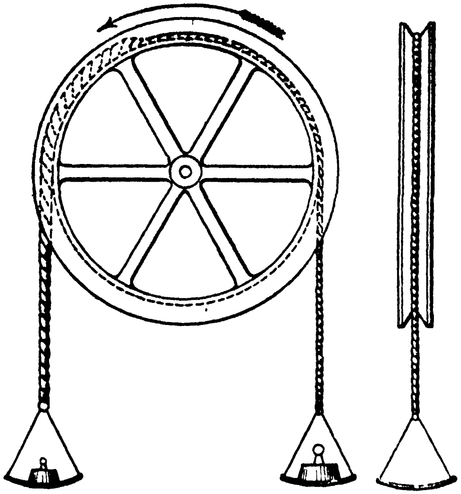


Fig. 63.

Raffard's Dynamometer is on the same principle—is, indeed, a modification of Carpentier's. In it the larger weight, instead of being fastened directly to the belt or rope, is hung from one end of a lever with equal arms, the belt being fastened to the other end. This arrangement will readily be understood from an inspection of Figs. 61 and 62, which are respectively an elevation of the apparatus and a plan of the pulleys. The weight *w* (Fig. 61) hangs on the belt *f*, which takes one half turn over the top of the fast pulley, and is fixed to the cross-bar *d d* (Fig. 62); two other belts *e* are fixed to *d*, lapped over the lower half of each loose pulley, and are then attached to the end of the lever G H (Fig. 61), from the other end of which the larger weight W is suspended. The motor to be tested is coupled directly to the shaft, which carries these pulleys, by means of a universal joint. The rule for calculating horse-power, in this and the last apparatus, is the same as the rule already given for the Prony brake, except that the *net* load $W - w$ is substituted for W, and R is the radius of the pulleys.

Ayrton and Perry's Absorption Dynamometer.—A much simpler and equally effective method of adjustment has been devised by Professors Ayrton and Perry. It is shown in Fig. 63. The belt or rope is of unequal roughness—shown as unequal thickness in the figure—and as the coefficient of friction diminishes by the wearing of the surfaces of the belt and pulley, a rougher portion of the belt is drawn on to the pulley and the friction automatically increased. The pulley is generally a flat one with projecting flanges, and the belt employed an ordinary leather or cotton belt, the necessary roughness being obtained by lacing the belt with a rough thong or lace. The rule for horse-power is the same as in the last case.

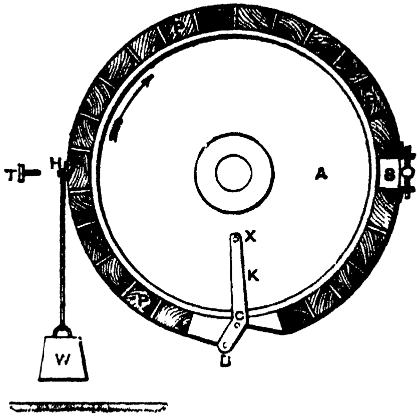


Fig. 64.

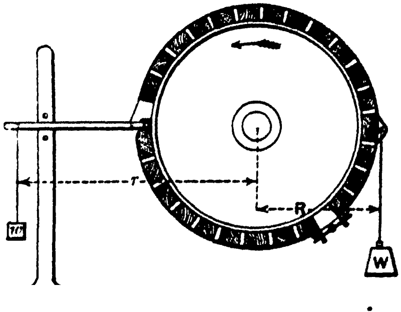


Fig. 65.

The Appold Brake.—The dynamometer of Messrs. Amos and Appold, which was formerly used in testing engines at the Royal Agricultural Society's Shows, has attracted considerable attention.

Its very ingenious automatic adjustment will be understood from an examination of Fig. 64.

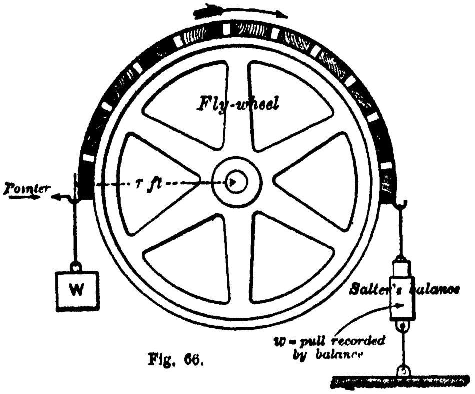


Fig. 66.

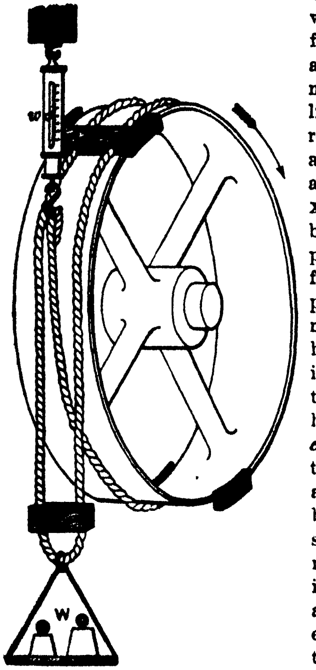


Fig. 67.

It will be seen that there is a screw S at one side for adjusting the brake-strap P to the proper tightness. The *automatic* adjustment is by means of the bent lever K, which, if the friction becomes a little too great, moves round a little in the direction of the arrow - head about the pivot X, the weight W being lifted. The point B being farther from the pivot than C, moves farther, hence the effect is the same as if the brake-band had been *lengthened*; the friction between it and the pulley being correspondingly diminished. There is, therefore, always a tendency to return to a condition of equilibrium, for should the friction become *less* the opposite effect is produced. This is a very ingenious arrangement, but it has been pointed out that there is an *unmeasured* force at the point X, which is greater the more the compensating lever comes into play; hence the indications cannot be relied on for accuracy. If, however, the compensating lever is arranged as shown in Fig. 65, *all* the forces can be taken into account. If things are so adjusted that the lever floats midway between the stops, the power absorbed is given thus, n having the meaning already given to it :—

$$HP = \frac{(W \times R - wr) 2\pi n}{33000}.$$

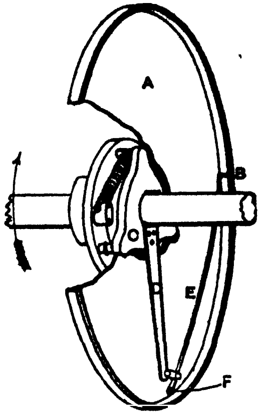


Fig. 68.

In recent tests of engines, conducted with great care, simpler forms of dynamometers—shown in Figs. 66 and 67*—were used. The reader will have no difficulty in understanding the action of each from an inspection of the figure. The brake-strap or rope may lap either half or completely round the pulley to which the power to be measured is supplied. The rule for both of these cases is

$$HP = \frac{(W - w) r \times 2\pi n}{33000},$$

W and w being measured in pounds, r in feet, and n in revolutions per minute. These brakes are easy to construct, work well, and give accurate results. The foregoing dynamometers are usually employed to measure the power given out by prime movers and motors, such as steam or gas engines, electro-motors, etc. On the other hand,

TRANSMISSION DYNAMOMETERS

are generally used to measure the power given to *power-absorbing* machines, such as pumps, etc. Some of them can remain in position permanently, so as to show at any time the amount of power passing through them to one or a number of machines.

Ayrton and Perry's Dynamometer Coupling.—Such an apparatus is the dynamometer coupling of Professors Ayrton and Perry. As shown in Fig. 68, it is really a coupling for connecting two lengths of shafting, not rigidly, as is usually the case, but through the medium of spiral springs, which yield and allow a certain amount of angular motion of

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* **Figs. 66 and 67 are, by kind permission, copied from the report on Mr. W. W. Beaumont's paper on "Friction-Brake Dynamometers" in the Minutes of Proceedings of the Institution of Civil Engineers, vol. xcv.**

the one half of the coupling or one length of shaft, relatively to the other. This yielding or relative motion is magnified in a most ingenious way, which, however, is somewhat difficult to understand from the picture. The bar D, instead of being as shown, is really fastened to the *farther* half of the coupling, and a pin from it engages a little link which acts on the light pointer pivoted at F. The direction of rotation is that shown by the arrow, and the farther length of shaft tends to get in advance of the nearer when power is being transmitted; hence the bar D pulls the end B of the pointer in nearer the centre of the shaft as the amount of power transmitted becomes greater. The pointer at B carries a bright silvered bead, which, rotating near the blackened disc A, seems to describe bright circles; and a scale arranged in front of the pointer gives the radius of that circle, or rather shows the distance, radially, of the circle the bead describes from that described by it when no power is transmitted. The reading on the scale, then, is a measure of the horse-power (really the *torque* or turning moment) transmitted if the speed of the shaft is known and constant.

Smith's Transmission Dynamometer or *Ergometer* is a very useful and ingenious instrument. It is shown in section in Fig. 69. It consists of a hollow shaft on which are mounted two pulleys, D fast and G loose on the shaft. The pulley D has attached to it the bearings for a bevel-wheel H, which gears with two others, K and M, the bearings of which are fixed to G. Wheels K and M have each a little drum attached, on which steel wire is wound in opposite directions in the two cases, the wire being attached to a cross-bar L passing through a slot in the shaft, this cross-bar being fastened to the end of a spiral spring A occupying the centre of the hollow shaft. Pulley D receives the power by a belt, and G gives it off after measurement. When power is transmitted, the pulley G tends to lag behind D, and this relative motion of the pulleys causes a relative motion of the bevel-wheels; K and M moving round on H and winding up the steel cord, therefore elongating the spring. **This elongation is really a measure of the *torque* applied to the shaft, and is shown by the pointer on the dial Q, the speed of the shaft being given by the speed indicator R. Hence the two factors of horse-power, *torque* and *speed*, are given, and the horse-power is obtained by multiplying the two readings together and dividing or multiplying by a constant number, which has been determined for the particular apparatus. This dynamometer has the great advantage over some others of giving the horse-power at *any* speed without the necessity of introducing a correction.**

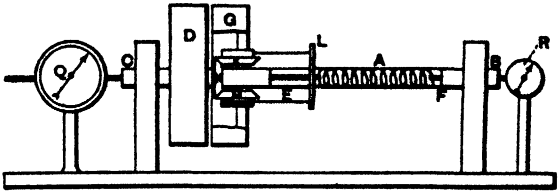

Fig. 69.

Hefner-Alteneck's Belt-tension Dynamometer.—This is the last dynamometer we have space to describe. It was first brought to public notice in this country in 1879. It is designed to measure the *difference of the pulls* in the two sides of a belt which transmits power. The principle of the instrument will be understood from Fig. 70, which, however, is only diagrammatic.

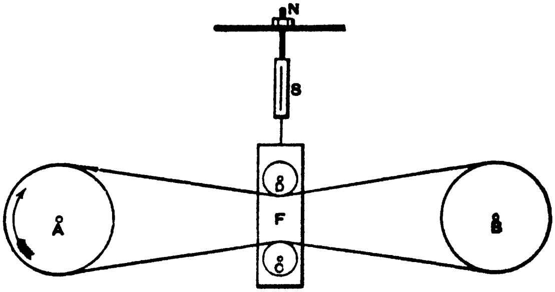

Fig. 70.

The pulley A receives the power and drives the pulley B by means of a belt, which is deflected over the guide-pulleys C and D, mounted on a frame which is guided to move vertically. The lower half of the belt being the tighter portion—since A drives in the direction shown—there is a tendency to move the frame F, carrying the guide pulleys, downwards against the pull of the spiral spring S, the nut N of which is tightened till the pulleys assume a symmetrical position as in the figure. When a larger amount of power is transmitted it takes a greater pull in the spring-balance to keep the guide-pulleys in the proper position, in fact the pull recorded in the spring-balance is a measure of the horse-power transmitted at any constant speed; **in reality it measures the difference of pull in the two sides of the belt, which the reader is already aware is proportional to the horse-power transmitted** if the speed does not vary. The actual form of the instrument is different from that shown, but the drawing illustrates the principle on which it works.

An instrument very similar to that shown in Fig. 70 has been used with success by Professor Elihu Thomson, of the United States, in measuring the power given to dynamo machines. In that case, Professor Thomson suspended the frame F from the short arm of a lever, the longer arm of which carried a movable weight. The lever was graduated so that the position of the movable weight indicated the horse-power transmitted at a certain speed. The student will gain much useful information by studying the way in which the elementary laws of mechanics are applied in the various machines described.*

NUMERICAL EXAMPLES.

1. A Prony brake is used to measure the useful horse-power of a certain steam-engine, the testing-pulley being keyed on the crank-shaft of the engine. It is found that there is equilibrium when a weight of 102 lb. is suspended from the lever, the centre of gravity of this weight being 8 feet from the centre of the pulley. If the speed of the shaft is 98 revolutions per minute, find the useful horse-power.

Referring to the rule given for this dynamometer, we have

$$\begin{aligned} HP &= \frac{102 \times 8 \times 6{\cdot}2832 \times 98}{33000} \\ &= 15{\cdot}28. \end{aligned}$$

2. A Raffard (Carpentier) dynamometer is used to measure the power given out by an electro-motor. If the weights W and *w* (Fig. 61) are 68 and 20 lb. respectively, the diameter of the brake-pulleys being 14 inches, and their speed 1,200 revolutions per minute, find the useful horse-power of the motor. If the motor receives a current of 62 amperes at a pressure or electromotive force of 100 volts, find its efficiency.

Referring to Fig. 61 it will be seen that the lever G H has *equal* arms, hence it serves merely to transfer the force due to the weight W to the belts at *e*, the dimensions of this lever not entering into the calculation.

The dynamometer really consists of a fast pulley F, with a belt lapped half round it, one end being pulled by a force of 68 lb., and the other by a force of 20 lb. The power absorbed is therefore

$$\begin{aligned} &\frac{(68 - 20)}{33000}\,\frac{7}{12} \times 2 \times 3{\cdot}1416 \times 1200 \\ &= 6{\cdot}4 \text{ horse-power nearly.} \end{aligned}$$

The efficiency of the motor, the ratio of the power it gives out to that which it receives

$$\begin{aligned} &= 6{\cdot}4 \div \frac{62 \times 100}{746} \\ &= {\cdot}77 \text{ or } 77 \text{ per cent.} \end{aligned}$$

3. The horse-power of an engine is measured by a simple dynamometer, such as that shown in Fig. 63, the weights being 210 and 30 lb. respectively, and the speed of the pulley 150 revolutions per minute. If the mean radius of the circle described by the centre of the rope or belt is 2½ feet, find the useful power of the engine.

Answer, 12·8 horse-power.

4. In using the modification of the Appold brake, shown in Fig. 65, it was found that there was equilibrium when the larger weight was 118 lb., its distance from the centre of the shaft being 2 feet 3 inches; the smaller weight being 20 lb., and its distance 4 feet 8 inches; and the speed of the brake-pulley 216 revolutions per minute. Find the power absorbed.

In this case the horse-power is

$$\frac{(118 \times 2{\cdot}25 - 20 \times 4{\cdot}66') \times 2 \times 3{\cdot}1416 \times 216}{33000},$$

which gives 7·08 as the answer.

5. In testing the efficiency of a certain machine, the power it received was transmitted through a Smith's transmission dynamometer; and it was noted that the dynamometer showed a torque of 480 pound-feet, and a mean speed of 178 revolutions per minute. Find the power transmitted.

Answer, 16·26 horse-power.

6. By means of a Hefner-Alteneck's belt-tension dynamometer, it was found that the difference between the pulls in the two sides of a belt which transmitted power was 188 lb., the diameter of the pulley driven by the belt being 15 inches, and its speed 280 revolutions per minute; find the amount of power transmitted by the belt.

Answer, 6·26 horse-power.

ITALIAN.—IX.

[*Continued from p. 96.*]

VOCABULARY.

Addormentato, *-a*, asleep.
Affabile, affable.
Ammalato, *-a*, ill, unwell.
Bagno, bath.
Capriccioso, *-a*, capricious.
Casa, house, home.
Chiesa, church.
Circospetto, *-a*, wary, cautious.
Dentro, within.
Destra, right hand.
Di fuori, without, out of doors.
Di sopra, up stairs, at the upper end or part, etc.
Fuori, out of.
Là giù, (*laggiù*), down there, below there.
Là su (*lassù*), up there.
Pigro, *-a*, lazy.
Sbalordito, *-a*, amazed, confounded.
Scortese, impolite, discourteous.
Scuola, school.
Sonnolento, *sonnachioso*, *-a*, sleepy.
Stravagante, eccentric, odd.
Svegliato, *-a*, awake.
Tavola, table.
Teatro, theatre.
Timido, *-a*, timid.
Vecchio, *-a*, old.

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* For a fuller treatment of this subject the student is referred to the "Proceedings of the Institution of Civil Engineers for 1889," the *Electrician* for 1883–84, and the *Mechanical World* for 1889.

EXERCISE 27.

Translate into English :—

1. Él-la non è ca-pric-ció-sa. 2. Í-o ê-ra sve-glí-o. 3. Noi e-re-vá-mo sba-lor-dí-ti. 4. É-gli fu di só-pra. 5. És-se só-no stá-te am-ma-lá-te. 6. Non siá-mo noi cir-co-spêt-ti? 7. Í-o ê-ra stá-to nel bá-gno. 8. Só-no és-se tí-mi-de? 9. Voi siê-te pí-gri (pí-gre). 10. Non siê-te voi stra-va-gán-ti? 11. Él-la ê-ra ad-dor-men-tá-ta. 12. É-gli è stá-to in i-scuô-la. 13. Noi fúm-mo di fuô-ri. 14. És-si só-no stá-ti a tá-vo-la. 15. Voi fó-ste lag-giù. 16. És-si fú-ro-no las-sù. 17. Noi siá-mo stá-ti a dês-tra. 18. Tu ê-ri son-no-lén-to.

VOCABULARY.

Abbenchè, though, although.
Accordo, agreement (*siamo d'accordo*, we are agreed).
Accorto, circumspect, wise, prudent.
Assiduo, assiduous.
Avvertito, warned, informed.
Cauto, wary, prudent.
Ci, there.
Collera, anger.
Deluso, deluded, deceived.
Di mezza taglia, middle-sized.
Dissipatore, squanderer.
Egli crede, he believes.
Etico, consumptive.
Già, already.
Imbecille, imbecile, weak, silly.
Impaziente, impatient.
Importuno, importunate, troublesome.
Ingannato, deceived.
Leale, loyal, true, honest.
Lesto, nimble, quick.
Magro, thin, slender.
Malsano, sickly.
Moderato, moderate, sober, temperate.
Orgoglioso, proud, haughty.
Parlare, to speak, talk.
Prodigo, lavish, prodigal.
Puerile, childish, puerile.
Rauco, hoarse.
Ricco, rich.
Scaltro, shrewd, wary, sharp.
Scialacquatore, prodigal, waster.
Si dice, they say.
Sincero, sincere.
Stimato, esteemed.
Temerario, rash, inconsiderate.
Tetro, dismal.
Valoroso, valiant, brave.
Umano, humane, kind.

EXERCISE 28.

Translate into English :—

1. Sí-i as-sí-duo. 2. Si dí-ce ch'í-o sí-a stá-to te-me-rá-rio. 3. Siá-mo u-má-ni con tút-ti. 4. Í-o non sa-rê-i co-sì tê-tro, se non fós-si mal-sá-no. 5. Non és-se-re im-pa-ziên-te. 6. Non sí-a co-sì pue-rí-le. 7. É-gli sa-rêb-be stá-to im-por-tú-no a tút-ti, se ci fós-se stá-to. 8. Non sa-rêb-be si má-gro, se non fós-se ê-ti-co. 9. Non sa-rém-mo stá-ti de-lú-si, se fós-si-mo stá-ti più cir-co-spêt-ti. 10. Siá-te leá-li e sin-cê-ri. 11. Sa-rêb-be-ro stá-ti più caú-ti, se fós-se-ro stá-ti av-ver-tí-ti. 12. Voi sa-ré-te ráu-chi. 13. Cré-do ch'él-la sí-a im-be-cíl-le. 14. É-gli-no sa-rêb-be-ro già qui, se fós-se-ro più lê-sti.

VOCABULARY.

Alcuno, some.
Appetito, appetite.
Armadio, clothes-press.
Avventore, customer.
Biglietto, note.
Bisogno, need.
Bisognevole, necessary, needful.
Bisogna, one must.
Bisogna che, I, thou, he, etc., must.
Cameriere, valet, gentleman's servant, waiter.
Carica, charge, place, situation.
Cattivo, bad.
Cento, hundred.
Certezza, certitude, evidence.
Chiave, key.
Cocchiere, coachman.
Concetto, idea.
Condiscendenza, condescension.
Condotta, conduct.
Contrario, the contrary.
Coraggio, courage.
Costume, habit, practice.
Credito, credit.
Danaro, money.
Desiderato, desired.
Di farlo, to do it.
Di vederla, to see her.
Dispiacere, annoyance, trouble.
Dito, finger.
Dopochè, *poichè*, since, seeing, inasmuch as, as.
Dubbio, doubt.
Dubitate, do you doubt.
Facoltà, riches, prosperity.
Fiorino, florin.
Gamba, leg.
Genio d'andarvi, a mind to go there.
Genitori, pl., parents.
Imbarazzo, embarrassment.
Inchiostro, ink.
Inquietudine, trouble, care.
Involto, packet, parcel.
Lingua, tongue.
Lo, it, him.
Lui, him.
Maestro di casa, house-steward.
Maggiore, greater.
Male, pain, soreness.
Male di testa, headache.
Merletto, lace.
Migliore, better.
Minore, less.
Moderazione, moderation.
Nastro, *fettuccia*, ribbon.
Nego, I deny.
Nemico, enemy.
Niente, *nulla*, nothing.
Noia, ennui, weariness.
Notizia, information, advice, news.
Ordine, order.
Ottenuto, obtained.
Partire, to depart.
Partenza, departure.
Paura, fear.
Pazienza, patience.
Piacere, pleasure.
Pietà, mercy.
Po' for *poco*, little.
Portinaio, door-keeper, porter.
Possibile, possible.
Posto, place, post.
Poteva scrivere, could write.
Potrà andarvi, he will be able to go there.
Presto, soon.
Precauzione, precaution.
Probabile, probable.
Prudenza, prudence.
Punta, point, top, end.
Quadro, picture.
Raccomandazione, recommendation.
Ragione, reason, right (*aver ragione*, to be right).
Rosolia, the measles.
Sai tu che cosa, dost thou know what.
Seco, with or about him.
Servitù, the servants, family establishment.
Sofferenza, patience.
Soggezione, constraint, awe, fear.
Speranza, hope.
Stima, esteem, regard.
Stufa, stove.
Taccuino, pocket-book, memorandum-book.
Tanto da fare, so much to do.
Tanto, *-a*, so much, as much, so many, as many.
Temperino, penknife.
Tempo, time.
Timor, fear.
Torto, wrong (*aver torto*, to be wrong).
Tosse, cough.
Vaiuolo, small-pox.
Viaggio, journey.
Visita, visit.
Vivacità, liveliness.
Vivere, to live.
Voglia d'andarvi, a mind to go there.
Vuole, he wants or wishes.

EXERCISE 29.

Translate into English :—

1. Sá-i tu che cô-sa í-o áb-bia? 2. Áb-bi pie-tà di me. 3. Bi-só-gna che áb-bia-mo ú-na stú-fa. 4. A-vrò un ca-me-riê-re. 5. Non è pos-sí-bi-le che ab-biá-te a-vú-to tán-to da fá-re. 6. Vuô-le che áb-bia-mo buôn con-cêt-to di lui. 7. Se tu a-vés-si pru-dên-za, non a-vré-sti tán-ti ne-mí-ci. 8. Du-bi-tá-te ch'í-o áb-bia a-vú-to ra-gió-ne? 9. Mi pá-re che tu áb-bi tôr-to. 10. A-vrêb-be a-vú-to la cá-ri-ca, se non a-vés-se a-vú-to ne-mí-ci. 11. A-vré-te un coc-chiê-re. 12. A-vrém-mo a-vú-to mag-giór pia-cé-re, se l'a-vés-si-mo a-vú-to ôg-gi. 13. A-vrêb-be più cré-di-to, se a-vés-se mi-gliór con-dót-ta. 14. Pá-re che ab-biá-te má-le di tê-sta. 15. Ab-biá-te co-rág-gio e pre-cau-zió-ne. 16. Bi-só-gna a-vér buô-ne gám-be. 17. Non né-go di a-vér-lo a-vú-to. 18. A-vên-do é-gli têm-po, potrà an-dár-vi. 19. A-vên-do é-gli a-vú-to má-le a un dí-to, non po-té-va scrí-ve-re.

VOCABULARY.

Caso, chance.
Chi, who.
Ch'io possa venirne a chiaro, that I should be able to come to the knowledge of it.
Da sperar, to hope for.
Divario, *differenza*, difference.
Droghiere, druggist, grocer.
Dunque, consequently, therefore, then.
Gente, people, folk, men.
Facesse parola, said a word.
Incisore, engraver.
Loro, them.
Modo, way, manner, means.
Nessuno, none, not one.
Persuadere, to persuade, convince.
Popolo, people, nation.
Qualche, some.
Verso, way, expedient.

Exercise 30.

Translate into English:—

1. C'è (*or* v'è, *also* èc-ci *or* èv-vi, v'ha *or* háv-vi) qui un quál-che in-ci-só-re? 2. Non v'è, (*or* c'è) nes-sú-no (*or* al-cú-no). 3. Ci só-no (*or* vi só-no) dú-e dro-ghié-ri. 4. Non cré-do che ve ne sí-a-no. 5. Dié-ci án-ni só-no (*or* fa). 6 V'è (*or* c'è) sêm-pre mól-ta gên-te. 7 C'é-ra-no (*or* v'ê-ra-no) de' pô-po-li. 8. Non c'e mô-do di per-sua-dér-lo. 9. Non c'è vér-so. 10 Dún-que non c'è da spe-rár pá-ce. 11. Vi fu tra ló-ro chi dís-se. 12. Non vi fu chi fa-cés-se pa-rô-la. 13. Non c'è cá-so ch'í-o pôs-sa ve-nír-ne in chiá-ro.

Vocabulary.

A long time, *un pés-zo.*
All, *tut-to.*
Already, *già.*
Arrived, *ar-ri-vá-to* (with *essere*).
As though, *có-me se.*
At home, *in cá-sa.*
Before, *a-ván-ti.*
But, *ma* (or *pe-ro*)
Country, *cam-pa-gna.*
Courier, *cor-rié re.*
Deceived, *de-lu-so.*
Discourteous, *in-ci-vi-le.*
Esteemed, *sti-ma-to.*
Favourable, *fa-vo-ré-vo-le.*
For this reason, *per-ció.*
Gone, *an-dá-to* (with *essere*).
Haughty man, *su-pér-bo.*
Here, *qui.*
Honoured, *o-no-rá-to.*
I doubt, *du-bi-to.*
I said, *dis-si.*
Ill, *am-ma-lá-to.*
In the mouth, *in boc-ca.*
Incautious, *in-cau-to.*
It, *ne.*
Kind, *u-ma-no.*
Last, *scor-so.*
Live, *vi-ve-te.*
Merchant, *mer-cán-te.*
Monday, *lu-ne-dì.*
Never, *má-i.*
Old, *véc-chio.*
Or else, *poi-chè al-tri-mén-ti.*
Parents, *ge-ni-tó-ri.*
Paris, *Pa-ri-gi.*
Returned, *ri-tor-ná-to* (with *essore*).
Sunset, *il tra-mon-tár del so-le.*
Suspicious, *so-spet-tó-so.*
That you may never repent, *af-fi-ne di non pen-tir-vi má-i.*
Sweet, pleasant, *dól-ce pia-cé-vo-le.*
Theatre, *teá-tro.*
There, *vi.*
They asked, *do-man-dá-ro-no.*
They say, *si di-ce*
Too credulous, *tróp-po cré-du-lo*
To see, *a ve-dé-re.*
Unless, *pur-chè — non.*
Weather, *tém-po*
When, *quán-do.*
Where, *dó-ve.*
Whether, *se.*
Who, *chi.*
With them, *con ló-ro.*
Word, *pa-rô-la.*
Young, *gió-va-ne.*

Exercise 31.

Translate into Italian:—

1. Who has been here? 2. The brothers of the young merchant have been here to see whether you were at home. 3. Where have they been? 4. They have been a long time in the country. 5. When were thy parents with thy uncle? 6. Last Monday, they had arrived there before sunset. 7. I should have gone there with them if I had not been ill. 8. They say that the courier has already returned from Paris, but I doubt it, unless the weather has been favourable. 9. They asked where you were. 10. I said that you were in the theatre.

Vocabulary.

Affair, *có-sa.*
All that thou wishest, *tút-to ciò che brá-mi.*
Believes, *cré-de.*
Count, *cón-te.*
Economical, *e-có-no-mi-co.*
Enough, *ab-ba-stán-za.*
Fine weather, *bèl tém-po.*
For, *in.*
Good intention, *buón pro-po-ni-mén-to*
Greater satisfaction, *mag-giór sod-dis-fa-zió-ne.*
He says, *di-ce.*
I do not think so, *nol cré-do.*
I doubt, *dú bi-to.*
In an agreeable manner, *ag-gra-de-vol-mén-te.*
Indeed, *in vé-ro.*
It, *lo* (before the verb).
It appears to me, *mi pá-re.*
It will be necessary, *con-ver-rà.*
Journey, *viág-gio.*
Just now, *pôc'án-si* (or *pó-co pri-ma*).
Many, *mól-ti.*
Means, *més-so.*
Necessary knowledge, *ne-ces-sá-ria co-gni-zió-ne.*
New, *nuó-vo.*
No, *non al-cú-no, -a* (putting *non* before the verb and *alcuno* in the place of *no*).
No, *nó.*
Nobody, *nes-sú-no.*
No longer, *non più* (putting *non* before the verb and *più* after it).
Now, *a-dès-so* (or *ó-ra*).
Patient, *pa-zién-te.*
Penknife, *tem-pe-rí-no.*
Perseverance, *co-stán-za.*
Poor, *pó-ve-ro.*
Probably, *pro-ba-bil-mén-te.*
Regular, *re-go-lá-to* (plur.) or *re-go-lá-re.*
Rich, *ric-co.*
Right, *ra-gió-ne* (*aver ragione*, to be right).
Some (in the sense of several), *al-cu-ni.*
Still, *ma per-tán-to.*
Tailor, *sar-tó-re* (or *sár-to*).
Thunderstorm, *tem-po-rá-le.*
To employ himself, *d'oc-cu-pár-si.*
To obtain this, *a ciò con-se-guí-re.*
Travelling-dress, *á-bi-to da viág-gio.*
What, *ciò che.*
Why—because, *per-chè.*
Will bring it me, *me lo por-te-rà.*
Will maintain, *vó-glio-no so-ste-né-re.*
Wrong, *tór-to* (*aver torto*, to be wrong).

Exercise 32.

Translate into Italian:—

1. Thou art right and he is wrong. 2. The count had much money, and now he is poor. 3. Why is he no longer rich? 4. Because he was not economical. 5. I do not think so; we shall probably have a thunderstorm. 6. I shall have a new travelling-dress; the tailor will bring it me to-morrow. 7. Be patient, and thou wilt have all that thou wishest. 8. It appears to me that thou hast no perseverance in thy good intentions. 9. Some will maintain that he has not the necessary knowledge. 10. I doubt whether he has had what he says.

Vocabulary.

After, *dó-po.*
A study of six months, *sé-i mé-si di stu-dio.*
To learn (be learnt), *im-pa-rá-re*
Blockhead, *stól-to* (or *sciôc-co*).
Body, *cór-po.*
Can, *si pós-sa.*
Cannot even, *non sán-no nep-pu-re.*
Comfortably, *co-mo-da-men-te.*
Convince, *per-sua-dé-re.*
Dollar, *scu-do.*
Evident, *e-vi-dén-te.*
Fine environs, *con-tór-no a-mé-no* (plur)
Greater good *mi-glior bé-ne.*
Here, *qui.*
How many, *quan-ti.*
Hundred thousand, *cén-to mi-la.*
Huygens, *U-gé-nio.*
Infinite number, *in-fi-ni-tà.*
Inhabitant, *a-bi-tán-te.*
I should much like to know accurately, *vor-ré-i bèn sa-pé-re di pre-ci-so.*
It has struck, *só-no suo-ná-te.*
Just now, *pôc'án-si* (or *in qué-sto pun-to*).
Maintained, *sos-te-né-va*
Maintains, *sos-tié-ne.*
Men, *uó-mi-ni.*
Mind, *mén-te*, f.
Moon, *lu-na.*
No, *non.*
Nowadays, *al di d'óg-gi.*
Obstinate, *o-sti-ná-to* (or *te-stár-do*).
Once, *u-na vól-ta.*
One, *si.*
Philosopher, *sá-vio* (or *fi-ló-so-fo*).
Prospect, *ve-dú-ta* (or *pún-to di vi-sta*).
Same person, *me-dé-si-mo.*
Say, *di-re.*
Sound, *sá-no, -a.*
Statue, *stá-tua.*
Ten o'clock, *le diè-ci.*
Think, *pén-sa-no.*
Three, *tre.*
Truth, *ve-ri-tà.*
Will oppose, *si op-pón-go-no* (dat.).
Would sell, *ven-de-rèb-be-ro.*
Would give away, *da-rèb-be-ro.*
Wretched man, *mi-se-rél-lo.*
Written, *scrit-to.*
Very little, *po-chis-si-mo.*

Exercise 33.

Translate into Italian:—

1. There is no means of convincing an obstinate blockhead. 2. There was once a philosopher who maintained that there is no greater good than a sound mind in a sound body. 3. Huygens maintains that there are inhabitants in the moon. 4. Are there fine environs and beautiful prospects here? 5. There are many who think that the Italian language can be learnt in three months comfortably;

and these same persons, after a study of six months, cannot even say: "I have written just now—It has struck ten o'clock just now—I should much like to know accurately," etc.

REGULAR VERBS.

The termination of the Indefinite Mood, Present Tense, of all Italian verbs is the syllable *-re*. The vowel immediately preceding this syllable is the characteristic letter of each Italian verb, predominant in most of its tenses, and determining the conjugation to which it belongs. This vowel is in the first conjugation *a*, as, *a-má-re*, to love; in the second conjugation *e*, as, *te-mé-re*, to fear, or *cré-de-re*, to believe; and in the third conjugation *i*, as, *sen-tí-re*, to feel. Some of the verbs of the second conjugation have the accent on the last syllable but one, or the penultima, as, *te-mé-re*, to fear; *sa-pé-re*, to know; *ve-dé-re*, to see; *vo-lé-re*, to be willing, etc. The others have the accent on the last syllable but two, or the antepenult, while the penultima is short (*ere bré-re*), as, *cré-de-re*, to believe; *lêg-ge-re*, to read; *pèr-de-re*, to lose; *vén-de-re*, to sell, etc.

We recommend the pupil to commit to memory and conjugate as many verbs as possible. It will be the easiest and shortest way of mastering the language. Here are the conjugations of the regular verbs, with some additional forms or terminations.

I. INDEFINITE MOOD.

Present Tense.

Am-áre, *to love.*	Tem-ére, *to fear.*	Sent-íre, *to feel* [1]

Past Tense.

Avére am-áto, *to have loved.*	Avér tem-úto, *to have feared.*	Avér sent-íto, *to have felt.*

Future Tense.

Avére ad am-áre, *or* éssere per am-áre, *to be about to love.*	Avére a tem-ére, *or* éssere per tem-ére, *to be about to fear.*	Avére a sent-íre, *or* éssere per sent-íre, *to be about to feel.*

Present Participle.[2]

Am-ánte, *loving*	Tem-ênte, *fearing.*	Sent-ênte, *or* senzi-ênte, *feeling.*

Past Participle.

Am-áto, *loved.*	Tem-úto, *feared.*	Sent-íto, felt.

Present Gerund.[3]

Am-ándo, *loving.*	Tem-êndo, *fearing.*	Sent-êndo, *feeling*

Past Gerund.

Avêndo am-áto, *having loved.*	Avêndo tem-úto, *having feared.*	Avêndo sent-íto, *having felt.*

Future Gerund.

Avêndo ad am-áre, *or* essêndo per am-áre, *being about to love.* -	Avêndo a tém-ere, *or* essêndo per tem-ére, *being about to fear.*	Avêndo a sent-íre, *or* essêndo per sent-íre, *being about to feel.*

II. INDICATIVE MOOD.

Present Tense.

Sing.	Á-mo, *I love.*	Tém-o, *I fear.*	Sênt-o, *I feel.*
	Á-mi.	Tém-i.	Sênt-i.
	Á-ma.	Té-me.	Sênt-e.
Plur.	Am-iámo.	Tem-iámo.	Sent-iámo.
	Am-áte.	Tem-éte.	Sent-íte.
	Ám-ano.	Tém-ono.	Sênt-ono.

Imperfect Tense.

Sing.	Amá-va, *or* amá-vo, *I loved.*	Temé-va, *or* temé-vo, *or* temé-a, *I feared.*	Sent-íva, *or* sent-ívo, *I felt.*
	Amá-vi.	Temé-vi.	Sent-ívi.
	Amá-va.	Temé-va *or* temé-a.	Sent-íva.
Plur.	Ama-vamo.	Teme-vámo.	Sent-ivámo.
	Ama-váte.	Teme-váte.	Sent-iváte.
	Amá-vano.	Temé-vano, *or* temé-ano.[1]	Sent-ívano.

Indeterminate Preterite.[2]

Sing.	Amá-i, *I loved.*	Temé-i, *or* temé-tti,[3] *I feared.*	Sentí-i, *I felt.*
	Amá-sti.	Temé-sti.	Sentí-sti.
	Amò.	Temè, *or* temé-tte.	Sentì.
Plur	Ama-mmo.	Teme-mmo.	Sentí-mmo.
	Ama-ste.	Teme-ste.	Sentí ste.
	Ama-rono.	Teme-rono, *or* temé-ttero.	Sentí-rono.

Determinate Preterite.

Sing.	Hô am-áto, *I have loved.*	Hó tem-uto, *I have feared.*	Hô sent-íto, *I have felt.*
	Hai am-ato.	Hai tem-uto.	Hái sent-íto.
	Ha am-ato.	Ha tem-uto.	Ha sent-íto.
Plur.	Abbiámo am-áto	Abbiamo tem-úto.	Abbiámo sent-íto.
	Avéte am-áto.	Avete tem-uto.	Avéte sent-íto.
	Hanno am-áto.	Hanno tem-uto.	Hanno sent-íto.

Indeterminate Pluperfect.

Sing	Avéva am-áto, *I had loved.*	Aveva tem-uto, *I had feared*	Avéva sent-íto, *I had felt.*
	Avevi am-ato.	Avevi tem-uto.	Avévi sent-íto.
	Aveva am-áto.	Aveva tem-uto	Aveva sent-ito.
Plur.	Avevamo am-ato.	Avevamo tem-úto.	Avevámo sent-íto.
	Aveváte am-ato.	Avevate tem-uto.	Avevate sent-íto.
	Avevano am-ato.	Avevano tem-uto	Avévano sent-íto.

Determinate Pluperfect.

Sing.	Èbbi am-áto, *I had loved.*	Èbbi tem-uto, *I had feared.*	Èbbi sent-íto, *I had felt.*
	Avésti am-ato.	Avesti tem-uto.	Avesti sent-íto.
	Èbbe am-áto.	Èbbe tem-uto	Èbbe sent-íto.
Plur.	Avémmo am-áto. ;	Avémmo tem-uto.	Avémmo sent-íto.
	Avéste am-áto.	Avéste tem-uto.	Avéste sent-íto.
	Èbbero am-áto.	Èbbero tem uto	Èbbero sent-íto.

Future

Sing	Amer-ò, *I shall love.*	Temer-ò, *I shall fear.*	Sentir-ò, *I shall feel.*
	Amer-ái.	Temer-ái.	Sentir-ái.
	Amer-à.	Temer-à.	Sentir-à.
Plur.	Amer-émo.	Temer-émo.	Sentir-émo.
	Amer-éte.	Temer-éte.	Sentir-éte.
	Amer-ánno.	Temer-anno.	Sentir-ánno.

Future Perfect.

Sing.	Avrò am-áto, *I shall have loved.*	Avro tem-uto, *I shall have feared.*	Avrò sent-íto, *I shall have felt.*
	Avrai am-áto	Avrái tem-úto.	Avrai sent-íto.
	Avrà am-áto.	Avrá tem-úto.	Avrà sent-íto.
Plur.	Avrémo am-áto.	Avrémo tem-úto.	Avrémo sent-íto.
	Avréte am-áto.	Avréte tem-úto.	Avréte sent-íto.
	Avránno am-ato.	Avránno tem-uto.	Avránno sent-íto.

Conditional Present.

Sing.	Amerè-i, *or* ameria, *I should love.*	Temerè-i *or* temería, *I should fear.*	Sentirè-i, *or* sentiria, *I should feel.*
	Amerè-sti.	Temere-sti.	Sentirè-sti.
	Amerè-bbe *or* ameria.	Temerè-bbe *or* temeria.	Sentirè-bbe, *or* sentiria.

Conditional Present.

Plur.	Ameré-mmo.	Temere-mmo.	Sentiré-mmo.
	Ameré-ste.	Temeré-ste.	Sentiré-ste.
	Ameré-bbero, *or* ameríano.	Temeré-bbero, *or* temeríano.	Sentiré-bbero, *or* sentiríano.

Conditional Past.

Sing.	Avrèi am-áto, *I should have loved.*	Avrèi tem-úto, *I should have feared.*	Avrèi sent-íto, *I should have felt.*
	Avrésti am-áto.	Avrésti tem-úto.	Avrésti sent-íto.
	Avrèbbe am-áto.	Avrèbbe tem-úto.	Avrèbbe sent-íto.
Plur.	Avrémmo am-áto.	Avrémmo temú-to.	Avrémmo sent-íto.
	Avréste am-áto.	Avréste tem-úto.	Avréste sent-íto.
	Avrèbbero am-áto.	Avrèbbero tem-úto.	Avrèbbero sent-íto.

III. IMPERATIVE MOOD.[1]

Sing.	Ám-a, *love thou.*	Tém-i, *fear thou.*	Sènt-i, *feel thou.*
	Non am-áre ám-i, *do not thou love.*	Non tem-ére tém-a, *do not thou fear.*	Non sent-íre sènt-a, *do not thou feel.*
Plur.	Am-iámo.	Tem-iámo.	Sent-iámo.
	Am-áte.	Tem-éte.	Sent-íte.
	Ám-ino.	Tem-ano.	Sènt-ano.

IV. SUBJUNCTIVE MOOD.*

Present Tense.

Sing.	Ám-i, *I may love.*	Tém-a, *I may fear.*	Sènt-a, *I may feel.*
	Ám-i.	Tém-a.	Sènt-a.
	Ám-i.	Tém-a.	Sènt-a.
Plur.	Am-iámo.	Tem-iámo.	Sent-iámo.
	Am-iáte.	Tem-iáte.	Sent-iáte.
	Ám-ino.	Tém-ano.	Sènt-ano.

Imperfect Tense.

Sing.	Amá-ssi, *I might love.*	Temé-ssi, *I might fear.*	Sent-íssi, *I might feel.*
	Amá-ssi.	Temé-ssi.	Sent-íssi.
	Amá-sse.	Temé-sse.	Sent-ísse.
Plur.	Amá-ssimo.	Temé-ssimo.	Sent-íssimo.
	Amá-ste.	Temé-ste.	Sent-íste.
	Amá-ssero.	Temé-ssero.	Sent-íssero.

Perfect Tense.

Sing.	Ábbia am-áto *I may have loved.*	Ábbia tem-uto, *I may have feared*	Ábbia sent-íto, *I may have felt.*
	Ábbi *or* ábbia am-ato.	Ábbi *or* ábbia tem-uto.	Ábbi *or* ábbia sent-ito.
	Ábbia am-áto	Ábbia tem-uto.	Ábbia sent-íto.
Plur.	Abbiámo am-áto.	Abbiámo tem-uto.	Abbiamo sent-íto.
	Abbiáte am-áto.	Abbiáte tem-úto.	Abbiáte sent-íto.
	Ábbiano am-áto.	Ábbiano tem-uto.	Ábbiano sent-íto.

Pluperfect Tense.

Sing.	Avessi am-áto, *I might have loved.*	Avessi temu-to, *I might have feared.*	Avéssi sent-íto, *I might have felt.*
	Avéssi am-áto.	Avessi tem-uto.	Avéssi sent-íto.
	Avésse am-áto.	Avesse tem-uto.	Avésse sent-íto.
Plur.	Avéssimo am-áto.	Avessimo tem-uto.	Avessimo sent-íto.
	Avéste am-áto.	Aveste tem-uto.	Avéste sent-íto.
	Avéssero am-áto.	Avessero tem-úto.	Avéssero sent-íto.

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* All Italian verbs in this tense are conjugated like the model verbs.

KEY TO EXERCISES.

Ex. 25.—1. Amo i miei fratelli e le mie sorelle. 2. Amo anche i miei cugini e le mie cugine. 3. Ho ricevuto due pomi (mele) e quattro pere da questo giardiniere. 4. Le mie ciriege sono bellissime. 5. Hai tu adacquato i tuoi fiori. 6. I tuoi fratelli hanno comperato due cani che sono molto fedeli. 7. Le mie sorelle hanno ricevuto due gatti da nostro zio; ne sono contentissime. 8. Le nostre sorelle sono partite questo settimana e nostra madre è molto trista. 9. I tuoi fratelli hanno ricevuto due toccalapis da mio cugino; eglino sono i suoi amici. 10. Ho comperato a Milano quattro specchi per le mie cugine. 11. Mia zia ha mandato sua figlia a Roma.

Ex. 26.—1. Adesso abbiamo continuamente belle giornate. 2. Egli aveva l'anno scorso un gran giardino fuor di città, nel quale trovansi bei fiori e begli alberi fruttiferi. 3. Quel libro tratta della vita di Santo Stefano e di San Giorgio, ed in questo vi sono spiegazioni d'alcuni passi dalle epistole di San Paolo e di San Pietro. 4. Teodosio il Grande morì a Milano nella braccia di Sant' Ambrogio. 5. Quello scritto contiene un bel pensiero sui vantaggi del commercio. 6. In questo affare bisogna avere gran circospezione e gran coraggio. 7. Demostene era un grand' oratore greco. 8. Egli è un buon giovane, e ha una gran disposizione d'imparar tutto facilmente. 9. Le perle, piccole o grandi, crescono in conchiglie, ed i coralli in mare in forma di arboscelli. 10. Goffredo ha una gran provigione di vino ungherese ed austriaco.

MINERALOGY.—I.

DEFINITION OF A MINERAL—PHYSICAL PROPERTIES OF MINERALS—CRYSTALLISATION.

MINERALOGY is the science of minerals, and the various definitions of the term *mineral* may be all summed up in a few words, as including all ***natural***, ***homogeneous***, ***inorganic*** substances. By the term ***natural***, as opposed to artificial, we exclude from the definition compounds made in the laboratory of the chemist, though in their form, optical characters, and other physical properties, no less than in their chemical features, these substances may throw much light on those resulting from the processes in Nature's laboratory. By the term ***homogeneous*** we imply that the whole of a mineral has one definite and uniform chemical composition, though variable traces of other substances may be occasionally present as impurities. The homogeneous character of minerals can thus be generally expressed by a chemical formula, and the processes of chemical analysis afford one of the chief methods of identifying minerals. This term excludes from the consideration of the mineralogist such rocks as granite or gneiss which, being made up of crystals of several distinct minerals, are by no means homogeneous. Other rocks, such as white marble or quartzite, which are entirely composed of one mineral substance, may be looked upon simply as massive modes of occurrence of such minerals. By the term ***inorganic*** we exclude such substances as pearl, amber, or coal, which are in structure, as well as in composition, of directly animal or vegetable origin.

Another definition describes a mineral as "an inorganic substance formed in the earth, possessing a definite chemical composition and a definite geometrical shape." This last character of definite geometrical shape is, however, not true of all minerals, whilst most minerals, though sometimes occurring in crystals, also occur in non-crystalline, indefinite, and ungeometrical shapes. Nevertheless, in conjunction with chemical analysis, crystallography, as the study of these definite geometrical forms or crystals is termed, affords the chief means of determining minerals. As there is often a close but practically unexplained connection between certain groups of compounds and certain groups of forms, though we classify minerals mainly upon a chemical system, this will be often found to correspond to a grouping based upon crystallisation.

We cannot here enter into details as to the chemical analysis of minerals, much of which has already been described in the lessons on Chemistry; but we may give a few of the leading principles.

The chemical characters of minerals are examined either by treatment with acids or in solutions, in the *wet way*, as it is termed; or in the *dry way*, by fusion, especially in the blow-pipe flame. The latter is the process generally adopted by the mineralogist in his first attempts at the rough or approximate identification of a specimen.

The chief indications afforded by examination in the wet way are the following:—

If a mineral effervesces on being treated with vinegar or dilute hydrochloric acid (HCl),* either cold or hot, giving off fumes which can be identified as carbon-dioxide (CO_2), it is a carbonate.

If on the addition of strong sulphuric acid (H_2SO_4) fumes are given off which will corrode the surface of a sheet of glass, they indicate a fluoride; non-corrosive fumes indicating a nitrate.

If the mineral, on being heated in strong acid, becomes gelatinous, it is a silicate belonging to a group known as *zeolites*.

If a mineral be dissolved, and a little silver-nitrate ($AgNO_3$) added to the solution, a white precipitate will be silver-chloride ($AgCl$) and will indicate a chloride, a yellow one will be silver-phosphate and will indicate a phosphate. A dense white precipitate on the addition of barium-chloride ($BaCl_2$) will be barium-sulphate ($BaSO_4$), and will indicate a sulphate.

The blow-pipe produces a steady continuous blast with the flame of a Bunsen burner, candle, or lamp. Two kinds of flame are produced: a short bright yellow flame, the *reducing flame* or *inner flame*, abbreviated as R.F. or I.F., because substances brought within it are deprived of oxygen or reduced; and a longer, blue flame, the *outer* or *oxidising flame* (O.F.), produced by a stronger blast, which oxidises substances.

Part of the substance to be examined (or *assay*, as it is termed) not exceeding a fifth or sixth part of all that is available for analysis, should first be heated in glass tubes open at both ends or at one end only. With the open tube volatile substances, such as ammonia, sulphur, selenium, arsenic, or antimony, if present, may be recognised by their characteristic odours; the presence of water may be detected by the condensation of steam on the glass; alkalies, such as soda or potash, will cause this condensed moisture to turn red litmus-paper blue, and acids conversely will turn the blue paper red; and oxides may be deposited on the tube. In the closed tube mercury, arsenic, or antimony will form *sublimates* or *mirrors*, being vaporised and redeposited on the cooler part of the inside of the tube.

Another portion of the assay may then be held in the blow-pipe flame by platinum-tipped forceps, provided it does not contain iron, lead, antimony, or any other substance that when heated would unite with the platinum as an alloy. The comparative ease or difficulty in fusing the assay, and the colour it gives to the flame, are then to be noted. Von Kobell drew up a *scale of fusibility* consisting of six minerals for comparison, viz., 1, antimonite, the most fusible, melting in a candle flame; 2, natrolite, which may be rounded at the edges when in thin splinters; 3, almandine-garnet, fusible before the blowpipe; 4, actinolite, only fusible in thin splinters; 5, orthoclase, fusible with difficulty, or can be rounded at the edges; and 6, bronzite, very infusible. A yellow flame indicates the presence of sodium; reddish-yellow, of calcium; violet, of potassium; carmine, of strontium or lithium; green, generally of copper-oxide, barium, or a phosphate; and blue, generally of sulphur, arsenic, antimony, lead, or copper. The yellow colouration by sodium is so universal and overpowering that the flame should be examined through a piece of cobalt-blue glass, which eliminates this colour, and will make the violet due to potassium visible.

A third portion of the assay should next be powdered, placed in a small hollow scooped out in a stick of charcoal, preferably beech-charcoal, and held in front of the oxidising flame. *Decrepitation*, or crackling, will then indicate the presence of water, of common salt ($NaCl$), or of some other chloride; *deflagration*, or flaring, will indicate nitrates or chlorates. If the assay melts readily or sinks into the charcoal it indicates some salt of one of the alkaline or earthy metals. If a white residue, or *areola*, remains as an incrustation round the hollow in the charcoal a drop of a solution of cobalt-nitrate should be added, and the flame again applied. A green colour will then indicate zinc-oxide; a blue one, alumina; and a pink, magnesia; whilst if the areola glows intensely and is not coloured by the cobalt, it is probably lime or strontium. If the residue be not white, a little sodium-carbonate (Na_2CO_3) may be added as a *flux*, to aid, that is, in the fusion of the assay, which should then be reheated in the inner or reducing flame, when a metallic bead will generally be produced. Effervescence during this fusion probably indicates silica (SiO_2).

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* See *Chemistry* lessons.

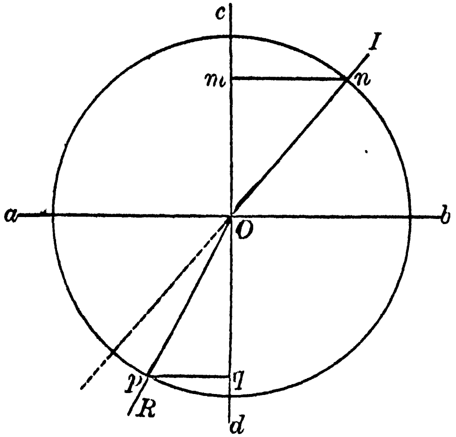

Fig. 1.—DIAGRAM TO ILLUSTRATE THE INDEX OF REFRACTION. *ab*, Surface of refracting substance; *cd*, perpendicular to that surface; *IO*, incident ray; *RO*, refracted ray.

$$\mu = \frac{\sin \angle IOc}{\sin. \angle ROd} = \frac{mn}{pq}.$$

Two other fluxes commonly employed are borax ($Na_2B_4O_7 + 10H_2O$) and microcosmic salt or hydrogen - sodium - ammonium - phosphate ($HNaNH_4PO_4 + 4H_2O$), which are made into small colourless beads in loops of platinum wire and yield characteristically coloured oxides and phosphates on being reheated with some of the powdered assay. The wire should be twisted into a loop less than an eighth of an inch across, heated, dipped into powdered borax or microcosmic salt, held again in the flame until a clear bead is formed, then dipped while hot into the powdered assay, and heated first before the outer flame and then in the inner one, its colour when hot and on cooling being noted on each occasion. Metals may separate out pure in borax in the reducing flame. A blue borax bead in both flames indicates cobalt; a green one, chromium. A green one cooling to blue before the oxidising flame and becoming red and opaque in the inner flame indicates copper; a reddish-yellow one similarly becoming bottle-green shows iron; and a violet one becoming colourless, manganese. Silica does not fuse in microcosmic salt, but remains in the bead unchanged. Oxides of iron with this flux are reddish, both hot and cold, in both flames.

Besides their chemical characteristics, minerals present various other physical properties which may be classified into—

1. Properties dependent upon light.
2. ,, ,, ,, heat-conductivity.
3. ,, ,, ,, electricity.
4. ,, ,, ,, magnetism.
5. ,, ,, ,, the state of aggregation.
6. ,, ,, ,, hardness.
7 ,, ,, ,, specific gravity.
8. ,, ,, ,, touch.
9. ,, ,, ,, odour.
10. ,, ,, ,, taste.
11. ,, ,, ,, form
12. ,, ,, ,, cleavage.

The chief optical characters of minerals, or those dependent upon light, are transparency, refraction, polarisation, lustre, colour, streak, and phosphorescence. These depend partly upon the transmission and partly upon the reflection of light.

Transparency, or diaphaneity (Greek *διά*, *dia*, through; *φαίνω*, *phainō*, I appear), the power of transmitting light, is distinguished under five degrees :—

1. *Transparent*, when the outline of objects may be seen through the mineral, as in rock-crystal, selenite, or Iceland spar.

2. *Semi-transparent*, when they are indistinct.

3. *Translucent*, when light is transmitted, but outlines are indistinguishable.

4. *Sub-translucent*, when light can only be seen through very thin portions, as in gold, hæmatite, etc.

5. *Opaque*, when no light is transmitted, as in magnetite.

Light, in passing from one medium to another, as from air into water or crystal, is bent out of its course or *refracted*. The degree to which this occurs is known as the *index of refraction* for the

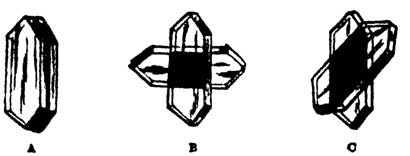

Fig. 2.—TOURMALINE PLATES FOR POLARISING. A, With parallel axes; B, crossed; C, in an intermediate position.

particular substance. It is the sine of the angle made by an incident ray of light with a perpendicular to the surface on which it falls, divided by the sine of the angle made by the refracted ray with that perpendicular (*see* lessons in Plane Trigonometry), and is represented by the Greek letter μ as a symbol. Thus, the index of refraction in fluor spar is 1·4, that of rock-salt 1·56, and that of garnet 1·8, whilst in diamond $\mu = 2{\cdot}4$ (Fig. 1).

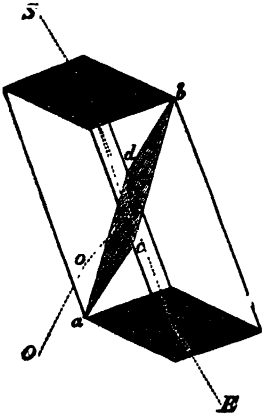

Fig. 3.—Nicol's Prism
SI, Incident ray of light; *IO*, ordinary refracted ray; *IE*, extraordinary ray; *abcd*, surface where the prism is re-united with Canada balsam.

Light passing through non-crystalline substances such as glass, or through substances crystallising in what we shall presently see is termed the Cubic system, as do the four minerals just mentioned, is all equally refracted, for which reason such substances are termed *singly-refracting* or *isotropic* (Greek ἴσος, *isŏs*, equal; τρέπω, *trĕpō*, I turn). Crystalline substances belonging to any other system are *doubly-refracting* or *anisotropic* (Greek prefix ἀν-, *an-*, not), that is they split up an incident ray of light into two rays, which are unequally refracted, and in different planes. These are termed the *ordinary* and the *extraordinary* ray, and the index of refraction of the latter is represented by the symbol μ'. Iceland spar, the pure transparent and colourless form of the mineral calcite ($CaCO_3$), has its two refracted rays so widely divergent that two distinct images of an object can be seen through it, and it is, therefore, often known as *doubly refracting spar*, but it must be remembered that all other minerals crystallising in any system except the Cubic share this character in some respect. In Iceland spar $\mu = 1{\cdot}67$, $\mu' = 1{\cdot}49$; in quartz $\mu = 1{\cdot}547$, $\mu' = 1{\cdot}556$, and in crocoisite, a lead-chromate ($PbCr_2O_4$), $\mu = 2{\cdot}5$, $\mu' = 2{\cdot}97$. If we look at any object through any of the faces of a rhombohedral crystal of Iceland spar, it will appear double; but there is one direction in which this will not occur, which is that of the principal axis of the crystal, the line joining its

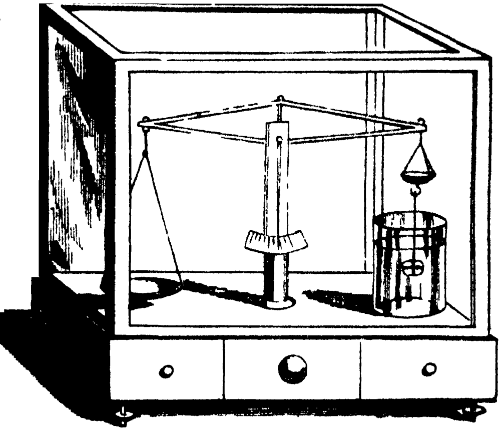

Fig. 5.—Balance for Determining Specific Gravities.

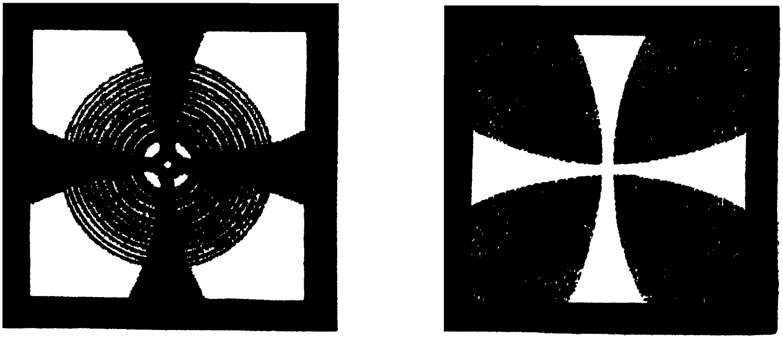

Fig. 4.—Rings and Crosses formed by Polarised Light passing through a Section of a Uniaxal Crystal cut perpendicularly to the Axis.

two similar solid angles. If, then, we grind down and polish these two angles, we can see the object singly through the crystal. This direction is termed the axis of single refraction or *optic axis*, and crystals having only one such direction of single refraction are called *uniaxal*. This is the case with all crystals belonging to what are known as the Rhombohedral or Hexagonal and the Pyramidal or Tetragonal systems, and in these systems the optic axis is always the chief axis of symmetry in the form—as, for instance, the long axis of the hexagonal prism of quartz, beryl, tourmaline, or apatite. Crystals belonging to the Prismatic, Oblique, and Anorthic systems have two optic axes, and are therefore called *biaxal*.

Ordinary light, as has been shown in the lessons on Light, consists of waves of ether taking place in various planes intersecting in one line, the direction of the ray; but when light is reflected at a certain angle or passes through certain substances, its vibrations or waves are all reduced to one plane, and are then said to be *polarised*. The instrument by which this change in the character of light is brought about is called a *polariser*. As the action of the polariser may be explained as intercepting all light except that vibrating in one particular plane, a second polarising apparatus will show the light to be polarised by entirely intercepting all that passes the first if the two are at right angles. A slice of some polarising mineral placed between the two instruments, by deflecting the ray of polarised light which has passed through the one instrument, causes it to fall upon the other instrument at a different angle, so that the light is not all intercepted. For this reason the second instrument is called an *analyser*. The simplest *polariscope* is the *tourmaline pincette*, which consists of two plates of the mineral tourmaline (Fig. 2) cut parallel to the principal axis of the crystal and mounted as a spring pincette with milled heads to rotate them. So long as their principal axes are parallel (Fig. 2A) they transmit light freely; but if at right angles (Fig. 2B), no light is transmitted unless some polarising substance be interposed. As plates of tourmaline are often dark-coloured, so as to transmit but little light, a pair of instruments known, from the name of the inventor, as Nicol's prisms, are commonly used instead. A Nicol's prism (Fig. 3) consists of a rhombohedral prism of Iceland spar bisected along a plane passing through its obtuse angles, the cut surfaces being polished and re-united with Canada balsam. As the index of refraction of this substance is intermediate between that of the ordinary and that of the extraordinary ray in Iceland spar, the ordinary ray is entirely reflected within the prism, the extraordinary ray alone emerging, in a polarised condition.

Polarised light passing through a section of a uniaxal crystal cut perpendicular to the optic axis exhibits a series of coloured concentric rings traversed by a symmetrical cross of light or shadow corresponding to the planes of vibration of the polariser and the analyser (Fig. 4). Similarly, crystals belonging to the Prismatic system exhibit two sets of rings symmetrically arranged round two brushes as figures of eight; Oblique crystals exhibit two dissimilar sets of rings; and Anorthic crystals two dissimilar sets divided into four unsymmetrical quadrants by the brushes.

The *lustre* of minerals varies in degree according to their reflective power, and varies in kind according to their structure, transparency, and refractive power. There are five possible *degrees of* each kind of *lustre*:—viz. (1) *dull*, when scarcely any white light is reflected, as in ochre; (2) *glimmering*, when light is faintly reflected, as in flint; (3) *glistening*, when there is a general surface reflection, as in mica; (4) *shining*, when an ill-defined image is reflected, as in celestine; and (5) *splendent*, when a well-defined one is produced, as in specular hæmatite and some pyrite. The *kinds of lustre* are six in number:—viz. (1) *silky*, accompanying fibrous structure, as in the form of gypsum known as satin spar; (2) *pearly*, occurring on faces of perfect cleavage, as in mica, selenite, and other minerals that are silky when fibrous (this is the lustre which renders of such value the nacre with which many molluscs line their shells. When a grain of sand or some other foreign substance finds its way within the shell, the animal, to allay the irritation, coats the intrusive grain with its beautiful polish. The reason the nacre possesses the pearly lustre arises from the fact that the creature deposits the substance in fine layers; the light reflected from their edges being in a condition to "interfere," as in the case of iridescence. That the play of colours is entirely due to this may readily be proved by pressing against the mother-of-pearl a piece of white wax, and it will be found that the wax now exhibits the colours. But the term pearly is generally applied to minerals having the appearance of nacre without the colour); (3) *vitreous* or *glassy*, in substances whose indices of refraction range from 1·3 to 1·8, as ice, fluor, glass, quartz, rock-salt, Iceland spar, and sapphire; (4) *resinous*, in translucent minerals when μ is between 1·7 and 1·9, as garnet; (5) *adamantine*, when μ is between 1·9 and 2·5, as diamond, blende, and crocoisite; and (6) *metallic*, in opaque minerals whose index exceeds 2·5, as galena and pyrites.

The external *colour* of minerals is so variable a character, even within the limits of single species, as to be of little discriminative value. Sapphire, for instance (Al_2O_3), occurs colourless (*lux sapphire*), blue, red (*oriental ruby*), purple (*oriental amethyst*), and other colours; and both fluor and rock-salt may similarly be colourless, violet, blue, green, yellow, orange, or pink. Some crystals of tourmaline are red for half their length, and green for the other half. The *streak*, or colour of a mineral when abraded or in powder is, however, of considerable importance; thus hæmatite (Fe_2O_3) is distinguished from limonite ($2Fe_2O_3+3H_2O$) by its streak being red instead of brown. Metallic minerals generally have a dark streak; non-metallic ones, a streak lighter than their colour The streak of minerals is obtained by rubbing them on slate or unglazed porcelain or scratching them with a file.

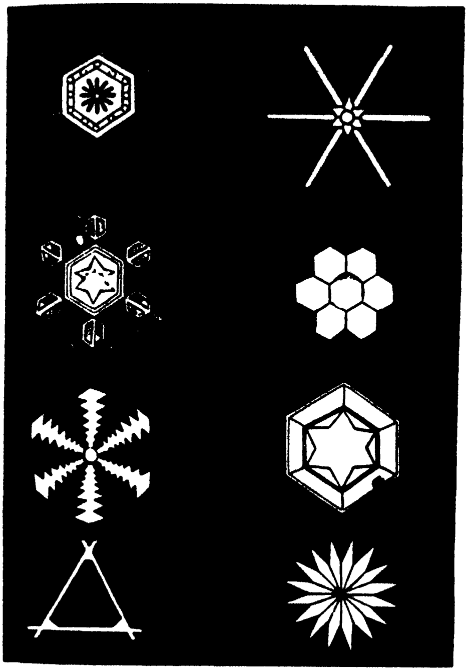

Fig. 6.

A *play of colours* is the appearance of rainbow-like hues within a mineral as it is rapidly turned, as in diamond and opal. It is due to unequal refraction of the waves of light. A *change of colours* is the slower succession of colours as the mineral is turned, as in labradorite. It seems entirely due to the presence of included fibres. *Opalescence* is a pearly reflection from the interior of the specimen, as in catseye. *Iridescence* is the display of rainbow-like colours within a mineral owing to internal flaws and the "interference" of the two sets of light-waves from the slightly separated surfaces. It is common in quartz. *Tarnish* is any surface-colouration, distinct from that of the interior of the specimen, resulting from decay or "weathering" on exposure. Tarnish is often *irised* from the separation of a thin surface film, as in window-glass exposed to the ammoniacal fumes in stables, in some coal, known as peacock-coal, and in some chalcopyrite, known as peacock-copper. *Dichroism*, *trichroism*, or *pleochroism* (Greek πλείων, *pleiōn*, many; χρόια, *chroia*, colours) is the transmission by certain doubly-refracting minerals of variously coloured light in two or three different directions, as in tourmaline, and in the aluminium-magnesium-silicate known as iolite or dichroite. *Fluorescence* is the exhibition by a mineral of one colour by reflected, and another by transmitted light, as in a green variety of fluor, owing to a retardation of the waves of light; and *phosphorescence*, or the giving out light in the dark, seems to be a closely related phenomenon Fluor, diamond, apatite, dolomite, and calcite are known as *pyro-phosphoric* as they phosphoresce when heated or when electrified; fluor, diamond, calcite, and gypsum are *heliophosphoric*, as they phosphoresce after exposure to sunlight; and quartz, blende, calcite, and dolomite may be termed *trito-phosphoric*, as they do so when rubbed, scratched, or hammered

The thermal and electrical characters of minerals, like their optical properties, are closely connected with their crystalline form. Crystals belonging to the Cubic system (*isotropic*) conduct heat and electricity, as they do light, equally in all directions Rhombohedral and pyramidal crystals (uniaxal) conduct most readily in the direction of their chief axis of symmetry or optic axis; whilst other crystals (biaxal) may when heated expand unequally in three perpendicular directions. Electricity may be produced in many minerals by friction; in some by heat; and in calcite, by pressure. Sulphur and diamond become positively electric on friction; nitre, fluor, and apatite, negatively. Tourmaline, topaz, and boracite are *pyro-electric* and exhibit *polarity*, their various edges and angles becoming charged with opposite electrical characters as they are heated, and reversing their action as they cool. This is mainly the case with what are known as *hemihedral* crystals (Greek ἡμι-, *hēmi*, half; ἕδρα, *hĕdra*, a basis), in which one half of the faces are differently modified from the other half.

Magnetism is chiefly exhibited by iron-ores such as magnetite or lodestone (Fe_3O_4). Ores of manganese, nickel, and cobalt are less magnetic, but attract a magnetic needle. Chalybite ($FeCO_3$) becomes magnetic on heating. Gold, silver, copper, mercury, lead, and tin, are examples of *diamagnetism*, being repelled by either pole of a magnet. The property is seldom of use in discrimination.

The characters which minerals exhibit dependent on their *state of aggregation* are (1) *molecular rigidity;* whether gaseous, as in volcanic exhalations; liquid, as in water, mercury, and naphtha; or solid; (2) *tenacity*, embracing (*a*) *sectility*, or capability of being cut, as in copper, graphite, selenite, and steatite; (*b*) *malleability*, or capability of being beaten into foil, as in gold, silver, copper, tin, lead, platinum, etc.; (*c*) *ductility*, or capability of being drawn out into wire, as in silver and copper more especially; (*d*) *flexibility*, the property of bending, as in talc; (*e*) *elasticity*, that of springing back after being bent, as in mica; and (*f*) *brittleness*, or breaking with ease into fragments, as in tourmaline and fluor; (3) *fracture;* and (4) *hardness*.

The surfaces of fracture are sometimes characteristic, especially the *hackly* fracture of cast-iron or other metals, rough with small projecting points, the *splintery* fracture of chert, hypersthene, or chlorite, resembling that of wood, and the *conchoidal* fracture, with shell-like concentric curves, as in quartz, flint, glass, etc.

The relative *hardness* of minerals is most useful in determining them. Kirwan was the first to arrange the table or scale now universally adopted; which is known by the name of *Von Mohs' scale of hardness*, that mineralogist having given the idea most publicity.

1. Talc, can be cut with the thumb-nail.
2. Rock-salt or selenite, can be just scratched with the nail or cut by a piece of copper.
3. Calcite, scratches, and is scratched by, copper.
4. Fluor, is not scratched by copper, but will not scratch glass.
5. Apatite, slightly scratches the softer kinds of glass, but is easily scratched by a knife.
6. Orthoclase-felspar, scratches glass easily, and can only be scratched by a good knife.
7. Quartz, can be scratched by a steel file.
8. Topaz.
9. Sapphire or corundum.
10. Diamond.

The pure crystalline variety of each mineral is taken as the type. That mineral which will scratch another is the harder of the two, so that by trying a mineral with the minerals named on the list, its relative hardness may at once be determined, and at least it may be pronounced what it is not. A good way to try the hardness of two minerals is to draw a file across them, and the way in which each is affected by the file will at once indicate their relative hardnesses. In the description of minerals, hardness is often abbreviated into H, and specific gravity into G.

The *specific gravity* of a mineral is its weight as compared with that of an equal bulk of distilled water at a temperature of 60° Fahr., which is taken as a standard. It is easily obtained by attaching the mineral to one scale of a balance by a hair, and then weighing it as it is immersed in a glass of water beneath the scale (Fig. 5). Subtract this weight from the ordinary weight of the mineral to find the weight of the water displaced, that is, of a volume of water equal to that of the mineral, and the ordinary weight of the mineral divided by this will be its specific gravity. There is a second method, which is applicable to porous minerals and those which can only be obtained in powder. A light glass bottle capable of containing 1,000 grs. of water is filled up to the mark on its neck with distilled water at 60° Fahr.; a few drops are poured out, and sufficient of the mineral is now added to make the water again reach the mark. The bottle is now weighed. The difference between this weight and 1,000 grs., divided by the weight of the water poured out, gives the required specific gravity. Or again, we may simply observe whether the mineral will float, sink, or remain where placed in some solution of a high known specific gravity, such as *Sonstadt's solution* of mercury and potassium iodide, which can be prepared with a density or specific gravity of from 2·6 to 3, *i.e.*, from 2·6 to 3 times as heavy as water.

The *touch*, or feeling of a mineral to the skin, is an unimportant character; but steatite, serpentine, and some other minerals containing magnesium have a soapy or greasy feeling which is characteristic. Neither is *odour* or smell of much use in discrimination. Ores of cobalt and arsenic give a garlic-like, or *alliaceous*, odour when hammered or heated; those of selenium smell of horse-radish when heated; sulphides and sulphur under similar conditions give a *sulphureous* odour; whilst stinkstone limestone yields the *fetid* smell of sulphuretted hydrogen (H_2S), and clays, serpentine, and many aluminous minerals give an earthy or *argillaceous* smell when breathed upon.

Taste is a test only applicable to soluble minerals. It may be *saline*, as common salt; *alkaline*, as soda or potash; *cooling*, as nitre and potassium-chlorate ($KClO_3$); *astringent*, as the vitriols; *sweetish astringent*, as alum; *bitter*, as epsomite ($MgSO_4$); or *sour*, as sulphuric acid (H_2SO_4).

In external *form* minerals may be either irregular or crystalline, *i.e.*, geometrically regular. *Irregular* or *indeterminate* forms may be common to many different mineral species. Among the more important are (1) *amorphous*, having no definite form, as chalk or ochre; (2) *nodular*, with irregularly rounded surfaces and protuberances, as flint; (3) *mammillary* or *botryoidal*, exhibiting spheroidal prominences, as malachite and kidney iron-ore; *stalactitic*, in icicle-like, pendulous, cylindric, or conical masses, solid or tubular, as calcite, chalcedony, baryte, etc., in which, however, small crystals are commonly detectable; and (5) *dendritic*, in tree-like or moss-like forms, as native copper and pyrolusite (MnO_2). Most minerals are, however, capable of assuming geometrically definite forms.

When from any cause a mineral has been deprived of its cohesion and its particles caused to separate, if the particles are permitted to associate themselves again to form a solid, in such a way that they can follow their own inclinations, the solid will give indications of being constructed according to certain laws. That is, the force of cohesion does not act equally in every direction, but in the great majority of instances sets itself to construct regular geometrical solids, called crystals.

The student can readily assure himself of the fact by taking any ordinary salt—common salt, or saltpetre, or alum—and adding it to boiling water until the water will dissolve no more. If he then suspend in the water a bunch of threads, and allow the solution to stand all night, in the morning the string will be found covered with crystals. The common salt will be in cubes, the alum in four-sided pyramids placed base to base. The larger the quantity of solution and the more slowly it cools, the larger will be the crystals. The presence of a substance which does not crystallise with the salt may modify the shape of the crystals. Thus, if in the solution of common salt urea be present, the crystals will no longer be cubes, but like those of alum, octahedra.

Many are the peculiarities of crystallisation. We might almost say that crystals in their formation exhibited signs of instinct. If a damaged crystal be suspended in a saturated solution of the salt which composes it, the salt out of the solution will begin to repair the damage, so that in a little time the general contour of the crystal will be restored. If in a solution there be small and large crystals, and the solution by an alteration of temperature be made alternately saturated and non-saturated, it will be found that the small crystals become entirely dissolved, while the large crystals grow. Crystals may also be got from a vapour condensing—sulphur, arsenic, iodine, offer examples of this—or from a liquid cooling. If, for instance, 8 or 10 lb. of sulphur or bismuth be melted and allowed to cool, and if when a crust has been formed it is removed, and the yet liquid substance be poured out, the cavity will be found lined with crystals; and often when a metal has been molten, and in its cooled state exhibits no signs of crystallisation, yet the existence of the phenomenon may be shown, if a weak solvent be applied to remove those particles which mask the formation. If a sheet of tin, while hot, be washed over with a weak solution of hydrochloric acid, the crystals which make the tin *moirée métallique*, and which previously existed, will appear. A bar of nickel, placed in dilute nitric acid, becomes covered with tetrahedra, because the acid dissolves the intervening uncrystallised metal. But, perhaps, the tendency of particles to arrange themselves in some order of polarity is most strikingly illustrated in solids which are constantly submitted to processes which move their particles. For example, the axle, or tire of the wheel of a railway carriage, by constant vibration, gives the particles of which it is composed the opportunity of taking positions according to the polarity of their kind. Of this opportunity they take advantage, and the consequence is that many axles, when broken after years of service, exhibit throughout their mass crystals of iron.

A very slight acquaintance with crystals will assure the observer that those of the same mineral have a close relationship in form. This will be illustrated by a glance at the snow crystals represented in Fig. 6. Although a great diversity is apparent, yet all the angles are equal, being those of an equilateral triangle, 60°; and it is the angles which are the constants in mineralogy.

MENSURATION.—II.

[*Continued from p. 104.*]

LINES AND AREAS OF SURFACE.

FOLLOWING up our subject from the point at which we left it in the former lesson, we subjoin a few examples in the measurement of sides of right-angled triangles, and then pass on to the consideration of triangles which do *not* contain a right angle.

EXAMPLE 1.—A wall is 30 feet high, and it is required to know what length a ladder must be which shall reach to its top, the foot of the ladder not being able to stand nearer the wall than 14 feet.

The 47th Proposition of the First Book of Euclid gives us at once the means of solving the question. The right angle is formed by the wall and the ground; the ladder is therefore the hypothenuse, or the side opposite to the right angle (*see* Definitions in "Geometry"), and this is equal to the square root of the *sum* of the squares of the base and perpendicular, or $\sqrt{30^2+14^2}=\sqrt{900+196}=\sqrt{1096}=$ $33\frac{1}{10}$ feet, approximately.

Example 2.—A ladder is 45 feet long, and when its foot rests upon the edge of the footpath, which is 12 feet wide, its top just reaches the eave of the roof. What height is this eave from the ground?

In this case the hypothenuse and base are known, and the height of the perpendicular is required. This, by the before-mentioned Proposition, is equal to the square root of the *difference* of the squares of the base and hypothenuse, or $\sqrt{45^2-12^2}=\sqrt{2025-144}=\sqrt{1881}=43\frac{1}{3}$ feet, approximately.

Example 3.—The side of a square is 9·774 feet; what is the length of the diagonal?

It is necessary here to observe that being a *square*, the sides of the figure are all equal; the length of the diagonal—which is, of course, the same thing as the hypothenuse of either of the triangles formed by the diagonal—will therefore be the square root of twice the square of one side. This will be in this case nearly 13·823 feet.

Example 4.—The side of an isosceles triangle is 65 feet, and the base 50 feet; what is the altitude?

The student must here remember that the sides of the isosceles triangle being equal, the perpendicular bisects the base; hence we have two right-angled triangles formed, in both of which the hypothenuse and base are equal, each to each; the base of each being one-half of that of the isosceles triangle. The rule for right-angled triangles will then apply, and the altitude or perpendicular will be found to be 60 feet

Exercise 1.

1. The base of a right-angled triangle is 4 feet 6 inches (54 inches), and the hypothenuse 7 feet 5 inches (89 inches) What is the height of the perpendicular?

2. The base being 513 feet, and the perpendicular 684 feet, what is the hypothenuse?

3. The hypothenuse is 2 feet 10 inches, and the base 2 feet 6 inches What is the perpendicular?

4. What is the side of a square whose diagonal is 8 feet 5 inches?

5. A ladder 50 feet long, being placed in a street, reached a window 40 feet from the ground, on one side of the street; but when the ladder rested against the house upon the other side of the street, the position of its foot not being altered, it reached a window 48 feet high. What was the breadth of the street?

6. What is the height of an equilateral triangle whose side is 1?

We subjoin a few examples having reference to the proportion which exists between the homologous sides of similar right-angled triangles, as explained in lesson I.

Example 1.—Two poles stand upright on level ground; the height of one is 10 feet, and its shadow projected upon the ground by the sun is 15 feet. The shadow of the other pole measures 150 feet. What is its height? *Ans.* 100 feet.

Example 2.—I wish to draw an oblong or right-angled parallelogram, similar to one whose length is 200 feet and breadth 20, but have only room on my paper to make the length 15 inches. What must be its breadth? *Ans.* $1\frac{1}{2}$ inches.

We shall now briefly glance at the relations which exist between the sides and angles of triangles which are not right-angled, that is, none of whose angles is a right angle

In the case of similar triangles, that is, of those in which any two of the corresponding angles are equal, no matter how great the disparity of the triangles as to area, the corresponding sides are all respectively proportional. This we have already noticed in our first lesson with respect to *right-angled* triangles, and the rule holds good in all similar triangles. Let A B C, *a b c* (Fig. 9) be two similar triangles, having the two angles at A and B equal to the two angles at *a* and *b*; then since the three interior angles of every triangle are equal to two right angles (Euc. I. 32), the angle at C must be equal to the angle at *c*, and the similar sides are proportional in each triangle—that is to say, A B is to A C as *a b* is to *a c*; hence if two sides of one triangle and a similar side of another and similar triangle be known, the other similar side of the second triangle is found by proportion. We may here observe that this simple and useful rule is equally applicable with respect to the similar lines of *all* similar figures, whether plane or solid.

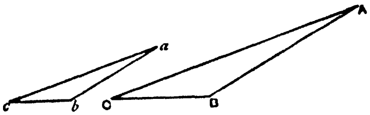

Fig. 9

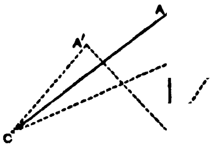

Fig. 10.

In calculating the length of the third side of a triangle, not right-angled—two being known—it is obvious that the rule of the squares (Euc. I. 47) cannot apply, and for this reason: when the angle formed by the sides is *variable*, the sides which contain that angle may remain the same as to length, while the hypothenuse may alter. Thus, let A B C (Fig. 10) be a triangle, whose angle B is a right angle—*i.e.*, contains 90°. From centre B, and with radius B A, describe a circle and draw any radii B A′, B A″, etc.; then join A′ C, A″ C, etc. These lines are evidently unequal, but the sides C B, B A′ and C B, B A″ are equal. In order to find the area of a triangle, it is desirable to ascertain the height of the perpendicular—that is, of the line falling vertically upon the base from the opposite angle—the base of the triangle being that side which is opposite to the angle from which we drop the perpendicular.

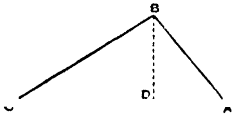

Fig. 11.

Given the three sides of a triangle, it is required to find the height of its perpendicular. Let A B C (Fig. 11) be a triangle of which A C is the base, it is required to find the length of the perpendicular B D. Let B C be greater than B A, then the part D C will be greater than the part D A (Euc. I. 18).

Then A C : B C + B A : : B C − B A : D C − D A, and $\frac{DC - DA}{2} + \frac{AC}{2}$ = the length of the greater segment D C, which being subtracted from A C gives the lesser segment D A.

We have thus ascertained the position of the point D. Then in either of the right-angled triangles A D B, C D B we have the two sides A D, A B and C D, C B, from which, by Euc. I. 47, we find the height of D B.

Next, having given the length of the base, and the height of the perpendicular of a triangle, to find its area. The rule is of the very simplest kind:—Multiply the base by half the perpendicular, and the result is the area of the triangle. The reason of this we will prove:—Let A B C (Fig. 12) be a right-angled triangle, right-angled at B. Complete the parallelogram A B C D by drawing C D parallel to B A and A D parallel to B C; then A C bisects it (Euc. I. 34). Now the area of a square or of a right-angled parallelogram is the product of any two adjacent sides. Hence A B × B C is the area of the parallelogram A B C D, but this is double the area of the triangle A B C (Euc. I. 41). Hence if A B × B C = area of parallelogram A B C D, A B × $\frac{BC}{2}$ = area of triangle A B C.

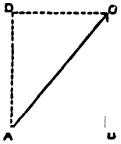

Fig. 12.

Exercise 2.

1. The base of a triangle is 6, and its two sides 5 and 7; what is its altitude?

2. The base being 8, and the two sides 10 and 6; required the altitude.

3. The three sides of a triangle are 21, 20, and 13; what is its perpendicular?

4. The base of a triangle is 5·96, and its altitude 3·81; what is its area?

5. The base of a triangle is 7·37 chains (1 chain = 66 feet), and the altitude 4·98 chains; what is its area?

6. The hypothenuse of a right-angled triangle is 205, and the base 200; required the area?

7. The side of an equilateral triangle is 3·4; what is its area?

8. Suppose the base of an isosceles triangle, whose area is 1 acre, is 363 feet; what is its altitude?

We subjoin another rule for the calculation of the area of a triangle *without* finding its perpendicular, the three sides being given:—From half the sum of the three sides subtract each side separately. Then multiply the half sum by the three remainders successively, and the square root of the product will be the area.

Example 1.—The three sides of a triangle are 13, 20, and 21; find its area by the above rule.

```
     13     27     27     27      27
     20     13     20     21       6
     21     --     --     --     ---
     --     14      7      6     162
 2 ) 54                            7
     --                         ----
     27                         1134
                                  14
                                ----
                                4536
                               1134
                               -----
                           √15876 = 126 Ans.
```

Exercise 3.

1. The three sides being 13, 14, 15, what is the area?

2. The side of a hexagon is 10; what is its area computed by both the foregoing rules?

3. The side of the base of a square pyramid measures 12 feet, and the perpendicular height 10 feet; what is the length of the slanting edge, and what the superficial area of the pyramid, base included?

Before proceeding further we will describe what are known as the trigonometrical functions of an angle. These are the sine, cosine, tangent, cotangent, etc.

The sine of the angle C A B is $\frac{CB}{AC}$, the cosine is $\frac{AB}{AC}$, the tangent is $\frac{CB}{AB}$, the cotangent is $\frac{AB}{CB}$; there are other functions, but these are all that we shall need in the present papers.

We shall now take our readers a step higher in our subject, but must of necessity introduce some matters which belong more particularly to

Trigonometry, and to our papers on that subject we must direct his attention for an explanation of those points he is unable to understand without it

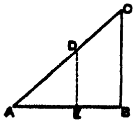

Fig. 13.

PROBLEM I.—Let A B C (Fig. 13) be a triangle, right-angled at B. Given the hypothenuse A C, and the angle C A B; required the length of the perpendicular B C.

$$\text{Since } \frac{BC}{AC} = \text{sine } CAB.$$

$$\therefore BC = AC \times \text{sine } CAB.$$

Rule.—Multiply A C by the natural sine* of the angle C A B; the result will be the length of C B.

Let H = the hypothenuse, P = the perpendicular, and S = the natural sine; then

$$\text{Cor.—Since } P = H \times S,\ H = \frac{P}{S}, \text{ and } S = \frac{P}{H}.$$

EXERCISE 4.

1. The hypothenuse of a right-angled triangle is 10·47, and the angle at the base is 58° 20′; what is the height of the perpendicular?

2. At what angle do we ascend a regular acclivity 6¼ miles long, attaining an altitude at the summit of 4268 feet.

3. The hypothenuse of a right-angled triangle is 89 yards 2 feet, and the angle at the base is 55°; what is the length of the base?

PROBLEM II.—To find the radius of a circle inscribed in a given triangle. *Rule.*—Divide twice the area of the triangle by the sum of its three sides.

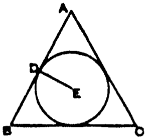

Fig. 14.

Let A B C (Fig. 14) be a triangle whose three sides are given: it is required to find the length of D E. Find the area of the triangle from previous rules, double it, divide the result by A B + B C + C A; the quotient will give D E.

EXERCISE 5.

1. The side of an equilateral triangle is 10; what is the radius of the inscribed circle?

2. The two legs of a right-angled triangle are 3 and 4; what is the radius of the inscribed circle?

3. The three sides of a triangle are 39, 60, and 63; what is the diameter of the inscribed circle?

PROBLEM III.—The side of a regular polygon (*see* Definitions in "Geometry") being given, to find the radii of the circumscribed and inscribed circles. *Rule.*—Divide 360 (the number of degrees in the whole circumference) by the number of sides in the polygon; the quotient will be the angle at the centre.

Let A B D E (Fig. 15) be a regular hexagon, of which the side A B is known; then by above rule the angle A O B is found. Halve this for A O C, and join O C. Then O C is perpendicular to A B, and bisects it, and the angle A C O is a right angle. Hence in the right-angled triangle A C O we have given the angle $AOC = \frac{AOB}{2}$ and the angle $OAC = 90° - AOC$, also the perpendicular $AC = \frac{AB}{2}$. Then (Problem I.) $AO = \frac{AC}{\text{sine } AOC}$ and $OC = AO \times \text{sine } OAC$.

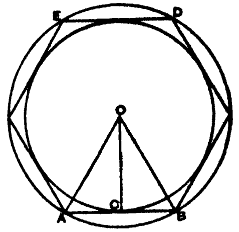

Fig. 15.

We append a few of the names of the chief regular figures:—A pentagon has 5 sides, a hexagon has 6 sides, a heptagon has 7 sides, an octagon has 8 sides, and so on.

EXAMPLE 1.—The side of a regular pentagon is 15¼ yards; what are the radii of the circumscribed and inscribed circles?

360° ÷ 5 = 72° = angle A O B (Fig. 15).
72° ÷ 2 = 36° = angle A O C; sine 36° = ·5878;
90° − 36° = 54° = angle C A O; sine 54° = ·8090;

$$\text{then } AO = \frac{15{\cdot}25}{2} \text{ or } \frac{7{\cdot}625}{{\cdot}5878} = 12{\cdot}972, \text{ about,}$$

$$\text{and } CO = 12{\cdot}972 \times {\cdot}8090 = 10{\cdot}495, \text{ about.}$$

EXERCISE 6.

1. The side of an octagon is 138 yards; what are the radii of the circumscribed and inscribed circles respectively?

2. The radius of a circle is 1·84; what will be the length of the side of a heptagon inscribed in it, and of an equilateral triangle described about it?

3. If 1 inch is the distance between the opposite sides of a decagon, what is the distance between its opposite angles?

We now come to the consideration of the relations which exist between the various lines connected with *circles*; and first of the proportion between the circumference and the diameter. If the circumference of any circular object be accurately measured with a tape, and then its diameter be also measured, it will be found that the circumference measures about $\frac{22}{7}$ times what the diameter does. This ratio is more correctly 3·1416 to 1.[*] Hence if D = diameter, C = circumference, and $\pi = 3{\cdot}1416$,

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* In Fig. 13, on A C measure A D = 1 on a scale of equal parts, and let fall from D the perpendicular D E on the base A B, then D E = natural sine of the angle C A B. To save time, the student should be furnished with a scale of sines, tangents, etc., for reference, for all the angles of the quadrant (90°) to within one minute. He will frequently require to refer to the table in calculations in Mensuration.

$$D = \frac{C}{\pi} \text{ and } C = D\pi$$

EXERCISE 7.

1. The diameter of a circle is 8; what is its circumference?

2. What is the circumference of the earth, supposing its diameter is 7958 miles?

3. The circumference of the earth at the equator being 24896 miles, what is its equatorial diameter?

4. What is the circumference of a circle whose radius is $2\frac{1}{2}$ feet?

5. A wheel revolves 1000 times in travelling a mile; what is its diameter?

6. Supposing the earth is always 94 millions of miles from the sun, and that it makes a complete revolution in its orbit in $365\frac{1}{4}$ days, how many miles per minute does it move?

SPANISH.—V.

[*Continued from p.* 110.]

THE VERB.

VERBS are classed into *active*, *passive*, and *neuter*; *reflective*, *regular*, *irregular*, *impersonal*, and *defective*. They are also varied by person and number, mood and tense.

Verbs have three persons and two numbers, as in English—that is, they vary their endings to agree with the person and number of their nominative; as—

	Singular.		*Plural.*
1*st. Pers.*	Yo hablo, *I speak.*	1*st Pers.*	Nosotros hablamos, *we speak.*
2*nd Pers.*	Tú hablas, *thou speakest.*	2*nd Pers.*	Vosotros hablais, *you speak.*
3*rd Pers.*	El habla, *he speaks.*	3*rd Pers.*	Ellos hablan, *they speak.*

In Spanish, it is not necessary to use the personal pronouns of the nominative case with the verb (unless for the sake of emphasis or perspicuity), as the ending of the verb indicates the person of its nominative. Thus, hablo means *I speak;* hablas, *thou speakest;* habla, *he speaks* or *she speaks;* hablamos, *we speak*, etc.

MOODS.

Mood is the form which the verb takes to show in what manner the action or existence is represented. In Spanish there are four moods—the *infinitive*, the *indicative*, the *imperative*, and the *subjunctive*.

The *infinitive* mood expresses action or being in an indefinite manner, without reference to person or time; as—

Hablar, *to speak.* Comer, *to eat.*

The *indicative* mood represents the affirmation in a positive manner; as—

Hablamos, *we speak.* Comeré, *I shall eat.*

The *imperative* mood expresses an order, entreaty, or command; as—

Hablád, *speak ye.* Coman, *let them eat.*

The *subjunctive* mood represents the affirmation in a conditional manner; as—

Aunque hablen, *though they may speak.*

TENSES.

Tense is the form which the verb takes to show the time of the action, being, or passion which is affirmed. There are properly three tenses, the *past*, the *present*, and the *future*. These are subdivided into eight tenses—one for the present, five for the past, and two for the future: the present, imperfect, perfect definite, perfect indefinite, the first pluperfect, second pluperfect, the first future, and future perfect or second future.

The *present* tense represents whatever is affirmed as taking place at the present time; as—

Hablan, *they speak.* Están comiendo, *they are eating.*

The *imperfect* tense represents as relatively present something which is affirmed as past, though, for all we know to the contrary, not yet completed; as—

Hablaban cuando los vió. *They were speaking when he saw them.*

The *perfect definite* tense represents what is affirmed as being completely past and finished; as—

Les habló ayer. *He spoke to them yesterday.*

The *perfect indefinite* tense represents what is affirmed as having taken place during a time not entirely elapsed; as—

Les he hablado hoy. *I have spoken to them to-day.*

The *first pluperfect* tense expresses what is past and was finished before another action, also past, was completed—that is, an event which occurred prior to some other past event; as—

Había hablado cuando llegó. *I had spoken when he arrived.*

The *second pluperfect* expresses that what is affirmed had taken place immediately before a time which is past, and is always employed after adverbs of time; as—

Cuando les hubo hablado, se marcharon. *When he had spoken to them, they went away.*

---

[*] The exact proportion between the circumference of a circle to its diameter, the diameter being 1, has never been found. It may be continued to more than 100 places of decimals.

The *first future* tense refers to some action or event which is yet to take place; as—

Hablará esta noche.	*He will speak to-night.*

The *second future* or *future perfect* tense refers to some future action or event that will have taken place at or before some particular future time; as—

Habré acabado á las ocho.	*I shall have finished at eight o'clock.*

PARTICIPLES AND GERUNDS.

Verbs in Spanish have two participles, the *present* and the *past*. There are, however, but few present participles in use, and these few are, almost without exception, employed only as adjectives or nouns—as, semejante, *similar;* obediente, *obedient;* viajante, *traveller*. The ending of the present participle of verbs that have their infinitive in *-ar*, is *-ante;* of those that have their infinitive in *-er* or *-ir*, is *-iente*.

The *past participle* denotes action or being perfected or finished, and, when derived from a regular verb, is generally formed by changing the final letters of the infinitive *-ar* into *-ado*, and *-er* into *-ido*; as—

Hablado, *spoken.*	Comido, *eaten.*

The *gerund* in Spanish is equivalent to the present participle in English, and is formed by changing the final letters of the infinitive in *-ar* into *-ando*, and *-er* or *-ir* into *-iendo*; as—

Hablando, *speaking.*	Comiendo, *eating.*

CONJUGATION.

In Spanish the infinitive mood of all verbs ends in *-ar*, *-er*, or *-ir*, and these terminations serve to distinguish the three conjugations; the *first* conjugation comprehending all verbs ending in *-ar;* the *second*, those ending in *-er;* and the *third*, those ending in *-ir*.

CONJUGATION OF THE AUXILIARY VERBS.

Note.—As stated on page 31, it is not necessary in Spanish to use the personal pronouns of the nominative case with the verb (unless for the sake of emphasis or perspicuity), as the ending of the person of each tense indicates the person and number of its nominative. In the conjugations which follow the pronouns will be omitted in Spanish.

As the auxiliary verbs are required to form the compound tenses of every other verb, we first give the

CONJUGATION OF THE AUXILIARY *HABER*, *to have*.

INFINITIVE MOOD.

SIMPLE TENSES.	COMPOUND TENSES.
Present.—Habér, *to have.*	*Past.*—Habér habído, *to have had.*
Present Gerund. — Habiéndo, *having.*	*Past Gerund.*—Habiendo habído, *having had.*
Past Participle.—Habído, *had.*	

INDICATIVE MOOD.

	Present.		*Perfect Indefinite.*
Sing.	He, *I have.*	*Sing.*	He habído, *I have had.*
	Has.		Has habído.
	Ha.		Ha habído.
	V. ha.		V. ha habído.
Plur.	Hémos.	*Plur.*	Hémos habído.
	Habéis.		Habéis habído.
	Han.		Han habído.
	VV. han.		VV. han habído.

	Imperfect.		*First Pluperfect.*
Sing.	Había, *I had.*	*Sing.*	Había habído, *I had had.*
	Habías.		Habías habído.
	Había.		Había habído.
	V. había.		V. había habído.
Plur.	Habíamos.	*Plur.*	Habíamos habído.
	Habíais.		Habíais habído.
	Habían.		Habían habído.
	VV. habían.		VV. habían habído.

	Perfect Definite.		*Second Pluperfect.*
Sing.	Húbe, *I had.*	*Sing.*	Húbe habído, *I had had.*
	Hubiste.		Hubiste habído.
	Húbo.		Húbo habído.
	V. húbo.		V. húbo habído.
Plur.	Hubímos.	*Plur.*	Hubímos habído.
	Hubísteis.		Hubísteis habído.
	Hubiéron.		Hubiéron habído.
	VV. hubiéron.		VV. hubiéron habído.

	First Future.		*Second Future.*
Sing.	Habré, *I shall* or *will have.*	*Sing.*	Habré habído, *I shall* or *will have had.*
	Habrás.		Habrás habído.
	Habrá.		Habrá habído.
	V. habrá.		V. habrá habído.
Plur.	Habrémos.	*Plur.*	Habrémos habído.
	Habréis.		Habréis habído.
	Habrán.		Habrán habído.
	VV. habrán.		VV. habrán habído.

IMPERATIVE MOOD.

Sing.	Háya, *let me have,* or *may I have.*	*Plur.*	Háyamos, *let us have,* or *may we have.*
	Ha, *have thou.*		Habéd, *have ye* or *you.*
	No hayas, *have not.*		No háyais, *have not.*
	Haya, *let him have,* or *may he have.*		Háyan, *let them have,* or *may they have.*
	Háya V., *have you.*		Háyan VV., *have you.*

SUBJUNCTIVE MOOD.

	Present.		*Perfect Indefinite.*
Sing.	Háya, *I may have.*	*Sing.*	Háya habído, *I may have had.*
	Háyas.		Háyas habído.
	Haya.		Haya habído.
	V. háya.		V. háya habído.
Plur.	Háyamos.	*Plur.*	Háyamos habído.
	Háyais.		Háyais habído.
	Háyan.		Háyan habído.
	VV. háyan.		VV. háyan habído.

	Imperfect.		*Pluperfect*
Sing.	Hubiéra, habría, *or* hubiése, *I would, should,* or *might have.*	*Sing.*	Hubiéra, habría, *or* hubiése habído, *I would, should,* or *might have had.*
	Hubiéras, habrías, *or* hubiéses.		Hubiéras, habrías, *or* hubiéses habído.
	Hubiéra, habría, *or* hubiese.		Hubiéra, habría, or hubiése habído.
	V. hubiéra, habría, *or* hubiése.		V. hubiéra, habría, *or* hubiése habído.
Plur.	Hubiéramos, habríamos, *or* hubiésemos.	*Plur.*	Hubiéramos, habríamos, *or* hubiésemos habído.
	Hubiérais, habríais, *or* hubiéseis.		Hubiérais, habríais, *or* hubiéseis habído.
	Hubiéran, habrían, *or* hubiesen.		Hubiéran, habrian, *or* hubiésen habído.
	VV. hubiéran, habrían, *or* hubiésen.		VV. hubiéran, habrían, *or* hubiésen habído.

	First Future.		*Second Future.*
Sing	Si hubiére, *if I should have.*	*Sing.*	Si hubiére habído, *if I should have had.*
	Si hubiéres.		Si hubiéres habído.
	Si hubiére.		Si hubiére habído.
	Si V. hubiére.		Si V. hubiére habído.
Plur.	Si hubiéremos.	*Plur.*	Si hubiéremos habído.
	Si hubiéreis.		Si hubiéreis habído.
	Si hubiéren.		Si hubiéren habído.
	Si VV. hubiéren.		Si VV. hubiéren habído.

By examining the above conjugation, it will be seen that, after having learnt the simple tenses, the compound ones are also known, as these latter are always formed by placing the past participle after the persons of the simple tenses of the auxiliary verb.

CONJUGATION OF THE AUXILIARY *SER, to be.*

INFINITIVE MOOD.

SIMPLE TENSES.	COMPOUND TENSES.
Present.—Ser, *to be.*	*Past.*—Habér sído, *to have been.*
Present Gerund. — Siendo, *being*	*Past Gerund.*—Habiéndo sído, *having been.*
Past Participle.—Sido, *been.*	

INDICATIVE MOOD.

	Present.		*Perfect Indefinite.*
Sing.	Soy, *I am.*	*Sing.*	He sído, *I have been.*
	Éres.		Has sído.
	Es.		Ha sído.
	V. es.		V. ha sído.
Plur.	Sómos.	*Plur.*	Hémos sído.
	Sóis.		Habéis sído.
	Són.		Han sído.
	VV. son.		VV. han sído.

	Imperfect.		*First Pluperfect.*
Sing.	Éra, *I was.*	*Sing.*	Había sído, *I had been.*
	Eras.		Habías sído.
	Éra.		Había sído.
	V. éra.		V. había sído.
Plur.	Éramos	*Plur.*	Habíamos sído.
	Érais.		Habíais sído.
	Éran.		Habían sído.
	VV. éran.		VV. habían sído.

	Perfect Definite.		*Second Pluperfect.*
Sing.	Fuí, *I was.*	*Sing.*	Húbe sído, *I had been.*
	Fuíste.		Hubíste sído.
	Fué.		Húbo sído.
	V. fué.		V. húbo sído.
Plur.	Fuímos.	*Plur.*	Hubímos sído.
	Fuísteis.		Hubísteis sído.
	Fuéron.		Hubiéron sído.
	VV. fuéron.		VV. hubiéron sído.

	First Future.		*Second Future.*
Sing.	Seré, *I shall,* or *will be.*	*Sing.*	Habré sído, *I shall,* or *will have been.*
	Serás.		Habrás sído.
	Será.		Habrá sído.
	V. será.		V. habrá sído.
Plur.	Serémos.	*Plur.*	Habrémos sído.
	Seréis.		Habréis sído.
	Serán.		Habrán sído.
	VV. seré		VV. habrán sído.

IMPERATIVE MOOD.

Sing.	Séa, *let me be,* or *may I be.*	*Plur.*	Seámos, *let us be,* or *may we be.*
	Sé, *be thou.*		Séd, *be you* or *ye.*
	No séas, *be not.*		No seáis, *be not.*
	Séa, *let him be,* or *may he be.*		Séan, *let them be,* or *may they be.*
	Séa V., *be you.*		Séan VV., *be you.*

SUBJUNCTIVE MOOD.

	Present.		*Perfect Indefinite.*
Sing.	Séa, *I may be.*	*Sing.*	Háya sído, *I may have been.*
	Séas.		Háyas sído.
	Séa.		Háya sído.
	V. séa.		V. háya sído.
Plur.	Seámos.	*Plur.*	Háyamos sído.
	Seáis.		Háyais sído.
	Séan.		Háyan sído.
	VV séan.		VV. háyan sído.

	Imperfect.		*Pluperfect.*
Sing.	Fuéra, sería, *or* fuése, *I would, should* or *might be.*	*Sing.*	Hubiéra, habría, *or* hubiése sído, *I would, should,* or *might have been.*
	Fuéras, serías, *or* fuéses.		Hubiéras, habrías, *or* hubiéses sído.
	Fuéra, sería, *or* fuése.		Hubiéra, habría, *or* hubiése sído.
	V. fuéra, sería, *or* fuése.		V. hubiéra, habría, *or* hubiése sído.
Plur.	Fuéramos, seríamos, *or* fuésemos.	*Plur.*	Hubiéramos,hubríamos, *or* hubiésemos sído.
	Fuérais, seríais, *or* fuéseis.		Hubiérais, habríais, *or* hubiéseis sído.
	Fuéran, serían, *or* fuésen.		Hubiéran, habrían, *or* hubiésen sído.
	VV. fuéran, serían, *or* fuésen.		VV. hubiéran, habrían, *or* hubiésen sído.

	First Future.		*Second Future.*
Sing.	Si fuére, *if I should be.*	*Sing.*	Si hubiére sído, *if I should have been.*
	Si fuéres.		Si hubiéres sído.
	Si fuére.		Si hubiére sído.
	Si V. fuére.		Si V. hubiére sído.
Plur.	Si fuéremos.	*Plur.*	Si hubiéremos sído.
	Si fuéreis.		Si hubiéreis sído.
	Si fuéren.		Si hubiéren sído.
	Si VV. fuéren.		Si VV. hubiéren sído.

KEY TO EXERCISES.

Ex. 15.—1. Who is good? 2. Who are rich? 3. Whose are the houses? 4. Whose books have you? 5. What did you say? 6. What hat have you? 7. What treasures has Peter found? 8. What language does the general speak? 9. What a man you are! 10. What a handsome woman! 11. Who wants bread? 12. Who speaks Spanish? 13. Who understands English? 14. Who loves truth? 15. Who understands what John says? 16. What sort of buttons do you want? 17. What kind of sugar has Peter? 18. What do you wish? 19. What books do the painters want? 20. What do the judges say? 21. What said the physician's brother? 22. Madam, do you want (some) butter? 23. Does your daughter understand English, madam? 24. No, sir, she does not understand English? 25. Whose buttons have the men-servants? 26. Who is hungry? 27. Who are thirsty? 28. What sort of spoons have the American's sisters? 29. What do Peter and John want? 30. Who understands what you say? 31. Who has some bread? 32. Whose are the books? 33. Which of the Frenchmen speaks Spanish? 34. Have you (some) money? 35. Have you many books? 36. Has the book leaves of gold? 37. Are not his friends rich? 38. Are not my brothers richer than the ship-carpenters? 39. Are the men-servants hungry? 40. Yes, sir, the men-servants are hungry.

Ex. 16.—1. ¿Quien es sabio? 2. ¿Quien es rico? 3. ¿Quienes son buenos? 4. ¿Quienes son cúlpables? 5. ¿Quien es fuerte? 6. ¿Quienes son robustos? 7. ¿De quien habla Juan? 8. Del médico. 9. ¿De quien son las casas? 10. De Pedro. 11. ¿Cuyos libros tiene María? 12. ¿Cuyos botones tienen los criados? 13. ¿Cuyas cucharas tienen mis hermanas? 14. ¿Cual de los dos hijos del médico halló un tesoro en la calle? 15. ¿Que dice V.? 16. ¿Que quiere Juan? 17. ¿Que dicen los jueces? 18. ¿Cuyo sombrero tiene V.? 19. ¿Que quiere V? 20. ¿Para quien escribió Juan las cartas? 21. Para a Francesa. 22. ¿Á quienes dió Juan los libros franceses? 23. Á las hijas del juez. 24. ¡Que muger! 25. ¡Que hermosa ciudad! 26. ¿Quien quiere azúcar? 27. ¿Quien habla el Ingles? 28. ¿Quien entiende el Español? 29. ¿Quien entiende lo que María dice? 30. ¿Que especie de cucharas tienen mis amigos? 31. ¿Que dicen las mugeres? 32. ¿Toma V. agua? 33. ¿Que dijo la hermana de Juan? 34. ¿Habla su hijo el Español, señor? 35. Si, señora, mi hijo habla el Español. 36. ¿Cuyas cucharas tiene la criada? 37. ¿Cuyo sombrero tiene Pedro? 38. ¿Cuyos botones tienen los pintores? 39. ¿Que libros tiene María? 40. ¿Que pan tienen VV.? 41. ¿Quien tiene sed? 42. ¿Quien tiene hambre? 43. ¿Es V. Español? 44. ¿Tienen las Españolas sed? 45. No, señor, las Españolas no tienen sed.

Ex. 17.—1. This man is rich? 2. That woman is proud. 3. Does that lady speak the English language? 4. Whose is this knife? 5. Whose are those forks? 6. He to whom my father wrote the letters has much money? 7. She to whom John gave a book is very handsome. 8. This house and that which you saw are mine. 9. Is not this the baker's son? 10. The hatter wrote these letters. 11. This looking-glass is mine. 12. This man is my friend. 13. Who is that woman? 14. This breeze is agreeable. 15. Whose is this pen? 16. Lucy's and Mary's spoons are of gold? 17. John has not my book, but he has that of my sister. 18. Have you my pens or those of my father? 19. Has the baker my bread or that of the carpenter? 20. The innkeeper's beer is as good as that of the shoemaker. 21. The wine of James is as good as that of Peter. 22. Have the printers my books or those of my friend? 23. The printers have not thy books, but they have those of thy friend.

Ex. 18.—1. Este caballero es bueno. 2. Aquella muger es hermosa. 3. Esas cucharas son nuevas 4. Aquellos pintores son pobres. 5. Estas casas son altas. 6. Esos sombreros son nuestros. 7. ¿De quienes son aquellas casas? 8. ¿Quien es ese caballero? 9. ¿Habla esa señora la lengua española? 10. Ese espejo no es viejo. 11. ¿Son estos mis zapatos? 12. ¿Cuyo es ese sombrero? 13. La Española y la Inglesa tienen prudencia, esa es mas amable que esta. 14. Aquellos á quienes Juan dió las plumas sono pobres é ignorantes. 15. Aquella á quien el sombrerero dió un espejo es pobre y sobérbia. 16. Lucía dió las cucharas á los que V. vió. 17. El librero dió tres libros á la que le escribió las cartas. 18. ¿No es esta la madre del zapatero? 19. Esos cuchillos son suyos de ella. 20. Estos tenedores son suyos de él. 21. ¿Quien es esta señora? 22. Diego no tiene mi libro, pero él tiene el de mi hermana. 23. Las calles de Lóndres son mas anchas que las de Madrid. 24. La pronunciacion del Frances no es tan fácil como la del Español. 25. Mi cerveza no es tan buena como la de Juan.

Ex. 19.—1. Every one of the three women has two looking-glasses. 2. These men will be rewarded, each one according to his deeds. 3. She and all her daughters are very robust. 4. Both know what is good. 5. Is there anything new? 6. There is nothing new. 7. The booksellers want nothing. 8. Everything which James has is mine. 9. Nobody speaks evil of him. 10. The shoemaker gave shoes to no one. 11. Nothing is good for him. 12. One knows not what to say. 13. Have you another brother? 14. Did anyone see my hat? 15. James found something on the road. 16. He who is rich, whoever he may be, will have anxieties. 17. To whomsoever you may give bread, James will give money. 18. Did John give books to some of these Germans? 19. Yes, sir, John gave books to some. 20. Has anybody my looking-glass? 21. Nobody has thy looking-glass. 22. Some men have money, others have not. 23. Many villagers of both sexes came to the city. 24. The painter gave a hat to the German, and a book to the Spaniard: both are poor. 25. Mary does not speak of another's faults. 26. Are there roses without thorns? 27. No, madam, there are no roses without thorns. 28. Are there in that house many rooms? 29. There are ten rooms. 30. John is not an American.

Ex. 20.—1. Los diez criados, cada uno de ellos tiene tres rosas. 2. Lucía tiene diez libros cada uno en un idioma diferente. 3. Todas las criadas serán premiadas, cada cual segun sus méritos. 4. María dió cuchillos á cada uno de ellos. 5. Todo lo que brilla, no es oro. 6. Todo libro tiene hojas. 7. Pedro no tiene nada. 8. Ninguna de estas señoras es rica. 9. No sabe uno que comprar. 10. ¿Tiene V. otra hermana? 11. ¿Habla alguien el Español? 12. El caballero tiene dos criados, y dió al uno diez pesos, y al otro doce, á cada uno segun su mérito. 13. El zapatero tiene dos hijas, el nombre de la una es Lucía, y el nombre de la otra es María. 14. Ella tiene algo que comer. 15. Una de las señoras vinó conmigo. 16. Mi hermana tiene todo lo que mi padre la dió. 17. Á cualquiera que María dé cucharas, Lucía dará tenedores. 18. Cualquier cosa que Juan diga, sus casas no son hermosas. 19. Dios aborrece todo camino malo. 20. Todo es muy cierto. 21. Nadie tiene tu espejo. 22. ¿Tienen algunas de estas mugeres tenedores de plata? 23. Cada uno de nosotros tiene algun mérito. 24. Mi sobrino no tiene plumas. 25. ¿Hay cartas para mi? 26. No, señor, no hay cartas para V. 27. ¿No hay libros sin hojas.

Ex. 21.—1. Time is more precious than gold. 2. Charity is patient. 3. Ignorance is the mother of error. 4. Prudence is more precious than silver. 5. Wisdom is better than beauty. 6. Man fears death. 7. Men are mortal. 8. Gold is precious. 9. John has gold. 10. Money is useful. 11. Peter has money. 12. Books are useful. 13. This year flour is very dear. 14. Butter is very dear. 15. Beer is good. 16. Death is terrible. 17. Milk is white. 18. John prefers vice to virtue. 19. Mary does not prefer error to truth. 20. Peter prefers riches to wisdom. 21. The physician prefers beer to wine. 22. Prudence and judgment are necessary to every man. 23. The peace of society depends on justice. 24. Silver is precious. 25. This year flour is not dear. 26. Religion is lovely. 27. Gold is more precious than silver.

Ex. 22.—1. El tiempo es precioso. 2. La prudencia es útil. 3. El vicio es odioso. 4. El dinero es útil. 5. El yelo es frio. 6. El azúcar es dulce. 7. La virtud es amable. 8. El agua es tan buena como el vino. 9. La vida no es un sueño. 10. La sabiduría es mas preciosa que todas las riquezas. 11. La beneficencia nos hace amables. 12. El hombre no teme la vida. 13. Ella tiene prudéncia. 14. Lucía no halló libros. 15. La leche es blanca. 16. El vino es muy caro este año. 17. La gratitud es el alma de la religion. 18. Los vinos serán buenos este año. 19. Los tenedores son utiles. 20. Este año la harina no es cara. 21. El ora es mas precioso que la plata. 22. La historia es maestra de la vida. 23. Este caballero prefiere la verdad al error. 24. Mejor es la prudéncia que el dinero.

THE ORGANS OF SENSE.—II.

[*Continued from p. 125.*]

I.—THE EYE (*continued*).

THE structures described in our last lesson, conducive to long sight in a thin medium, are more especially to be remarked in soaring raptorial birds, like the eagles, vultures, and hawks. These, as they wheel round at a great height, survey a large extent of country; yet their sight is so keen at that elevation that no young unprotected animal, or maimed and disabled prey, escapes their sight. So keen is the sight of the condor of the Andes that if a carcase be exposed where the naked eye can detect none of these creatures in the horizon, yet in a few minutes they are seen streaming in from all directions straight towards the hoped-for meal.

But though birds be long-sighted, it is also highly necessary that they should see minute objects at a short distance. No entomologist will deny that an insectivorous bird must have keen eyes for short distances if it is to get its living with ease. A microscopic sight is scarcely less requisite for a grain-feeding bird. The swallow, which plunges with such reckless impulse through the air, will nevertheless seize a small insect as it dashes along with almost unerring certainty. Usually the prey is so small that the wonderful powers of the bird displayed in the chase cannot be observed; but sometimes, when the insect has large wings, this dexterity may be seen.

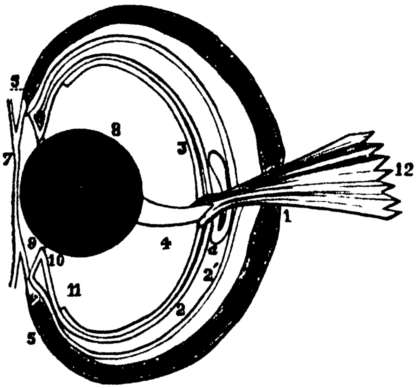

Fig. 4.—Vertical Section of the Eye of a Fish.

1, sclerotic; 2, choroid, 2', inner layer of choroid; 3, retina; a, choroid gland; 4, vitreous humour; 5, bony supports of sclerotic or hard coat; 6, iris; 7, cornea; 8, lens; 9, aqueous humour; 10, lens ligament; 11, ciliary processes; 12, optic nerve.

The writer has seen a swallow seize, while in headlong flight, the beautiful scarce swallow-tail butterfly, and shear out its sapid body from between the wide wings, and let them float severally down; and then, not satisfied with a feast so little proportioned to the splendour in which it was dished up, glance round and seize again the several pieces before they had time to reach the ground. How, then, is a long sight and a keen short sight to be obtained from the same eye? This is done mainly by the aid of the bony plates already described. These are so disposed that the edge of one is capable of sliding over the edge of its next neighbour, so that when the fibres of the muscle which unites them contract they compress the eye all round and make it more tubular, while the humours of the eye, thus subjected to pressure, cause the cornea to protrude more, and also the retina to be removed farther from the lens. The muscle, too, for adjustment to distance, is finely banded, whereas in beasts it is smooth; and physiologists know that banded or so-called striated muscle contracts more rapidly than the smooth or non-striated.

Intimately connected with this pressure upon and alteration of the dimensions of the humours of the eye is, probably, another peculiarity in the eye of a bird. This is a puckered purse-like membrane, which is attached to the optic nerve, which in this class enters the eye by a slit-like opening. This membrane is sometimes called a marsupium, from its resemblance to a purse, and sometimes a pecten, from its supposed likeness to a comb. It stretches to the interior of the eye to a varying extent in different birds, and is composed of a tangled mass of blood-vessels, mixed with pigment granules. Whether this is simply an erectile organ, which can rapidly contract and enlarge suddenly as it is deprived of or injected with blood, or is capable of feeding the vitreous humour with liquid strained by it from the blood, and draining it off again as circumstances require, is not known.

The eyes of reptiles are so different from one another, ranging in structure between the eye of the bird and that of the fish, that it is better at once to pass on to a description of an eye adapted to sight in water.

A fish (Fig. 4), living as it does in an atmosphere which is many hundred times denser than air, and by no means so transparent, must have an eye suited to look at near objects. It must therefore be able to concentrate the rays of light rapidly; yet it is under this disadvantage, that—as it is only when passing from a rare into a dense transparent convex substance that diverging rays are bent towards one another and the original rays pass through a dense medium—the cornea and aqueous humour can play no part in the bending of the rays towards one another, for they are of about the same density as water. The whole duty of refraction must thus be done by the lens. This is very dense, and the sheets of which it is made up on the inside are denser than the outside, while it is so convex both before and behind as to become a perfect globe.

Both the consistence and shape of the round lens may be seen by squeezing it out of the eye of a cooked fish, even by those whose taste for comparative anatomy is only stimulated at the dinner-table.

In connection with this kind of lens we have a shallow eye. In other words, if the cornea, through which light enters, be turned upwards, the back of the eye on which the retina is spread resembles a saucer, and not a cup, as it does in beasts and birds.

This is so much the case, that even though the hard capsule is shallower than in brutes, there is still left a large space between this and the choroid, and even this latter has between two of its layers a horseshoe-shaped "gland" composed of blood-vessels, something like the pecten of a bird, though in a different place, and with a different function.

The hard outer coat is strengthened and held to its form by a cup-shaped bone or cartilage, which occupies the parts which are left unoccupied by the bird's eye-bones; because while the latter are used to elongate the eye this maintains a shortened axis.

The cornea, or window, and the watery fluid behind it, being useless to collect the rays, are left, the one flat and the other in small quantity, and the result of this is that fish can see distant objects as well through the air as through the water; and this is important, because almost all fish are surface fish; many feed on flies, and most have to be on their guard against aërial foes. The reader, then, need not be surprised when the sun-loving shoals of carp or chub all plunge headlong into the depths when he appears on the river bank.

As a singular instance of the adaptation of means to ends, it is found that all animals, whether reptiles, birds, or brutes, which are amphibious, or which spend much time in the water, have eyes which, though they differ from those of fish in some things, have the same relation of the cornea and lens. Thus the whale and the dolphin (which are beasts which have taken to the sea), the cormorant and diver, the frog and the crocodile, have all spherical lenses and flat corneæ.

Fish and frogs have on the outer layer of the choroid a layer of silvery or golden crystals, and this layer, which is continued round till it occupies the front layer of the iris, gives to the toad so metallic and bright an eye as to countenance the legend that it has a jewel in its head. So Shakespeare—

> "The toad, ugly and venomous,
> Wears yet a precious jewel in its head."

The eyes of the animals lower than fish, none of which have a backbone, and which are called invertebrate animals, are closely related to their powers of moving from place to place. If an animal can dart rapidly about, more especially if it can move swiftly for some time at a stretch, its eyes are usually very perfect; but if it can only crawl sluggishly, its eyes are of an inferior structure.

We shall here only discuss the eyes of two great divisions of the so-called lower animals. The type of the one, called mollusca, shall be the snail; and of the other, named articulata, or arthropoda, the honey-bee may be taken as the representative.

It is impossible to say that either of these two sub-kingdoms is the higher, but they are very different. That of which the insect is the type is noted for the swiftness and agility of the movements of the animals that form it; while the other is equally remarkable for the sluggishness of the species which compose it. Indeed, the word just used is derived from this peculiarity in the slug.

These peculiarities are, however, but general ones, applying to most, but not all the species of each sub-kingdom; for each sub-kingdom contains several thousands of different kinds of animals. Thus we find some insects more inert than most slugs, and some of the slug class as active as many insects.

The eye of the garden-snail is evidently an organ not altogether comparable to the eyes we have described as those of the higher classes. It is situated at the end of the longer and upper pair of tentacles, and is only exposed when these are at their longest. Even when so exposed, its sense of sight is so obtuse that it seems only conscious of light and darkness as our skin makes us conscious of heat and cold, and has no knowledge of images. The organ seems little better than a refined organ of touch, for garden-snails will withdraw their eyes far sooner if blown upon, or the hand be placed between them and the light, than when threatened by the fingers. Nevertheless, the eye has a spherical lens, sclerotic, choroid, and retina, but all of comparatively simple structure. The most remarkable circumstance connected with this eye is that it can be retracted by drawing it down through the tubular horn, as one might draw the end of the finger of a glove down through the rest of the finger; and this is done by a special muscle, which is a slip of the great muscular band with which the snail draws in, not only its horns, but its whole head, strongly though slowly.

The eye is exposed by a successive contraction of the circular muscles which are round the horn, beginning at the base and ending at the top; this action has the same effect on the parts of the tube, and finally upon the eye, as driving a coin into the end of an old-fashioned purse by the aid of a ring which slides on the outside. The rest of the slugs and snails, which creep on their bellies, have eyes somewhat similar, and similarly situated; but while the garden-snail has four horns, or, more properly, tentacles, some water-snails have only two, and the eyes are placed on the outside of these, half-way up, while the whip-like extremities act as feelers, as the short horns of the garden-snail do. The bivalve mollusca have eyes inferior even to these, though they are sometimes numerous and curiously placed; thus, the kind of oyster which occupies the fan-shell, and is called a pecten, has a row of eyes running round the edge of the two sides of the animal's cloak, which lines the two shells that enclose it.

The highest class of mollusca, such as the octopus, have greater power of motion than any of the rest, and swim rapidly through the sea, both backwards and forwards, seizing their prey with long whip-like arms; and these creatures have large and elaborate eyes, not unlike those of vertebrates, but even more complex in some respects.

Turning now to the articulate sub-kingdom, we find in it eyes of the most remarkable description. They are best explained by the diagram.

If we examine the head of a wasp or bee, we find on the top of the head, looking towards the sky, three eyes set in a triangle. These eyes are simple (Fig. 5), and not unlike the eyes of many lowly organised creatures; but besides these, on the side of the head, stretching almost from its crown to the jaws beneath, are two compound eyes, which, under the microscope, are seen to present innumerable six-sided spaces, which look like the ends of the cells of a honeycomb. On dissection, each of these six-sided faces is found to be the outer surface of a double convex lens, behind which is a layer of black pigment, which is comparatively thick at the edges of the lens, but thin towards the centre, where a hole is left through its middle. This hole serves as the pupil. Behind the pigment is a cone of transparent matter, whose point is directed inwards, and embracing this point is the end of a nerve thread. The threads from each eyelet run inwards to a sheet of nervous matter common to the whole eye, and from this sheet other nerve cords, but much fewer in number than the first, run to the thick main optic nerve. The space between the nerve cords is filled up with black pigment, so that each can only receive impressions from its end. An insect, therefore, one would think, receives thousands of distinct pictures; but it so harmonises them in its common retina as to form a continuous image such as we make with our two eyes; unlike ours, it is not, however, a reversed but an upright image.

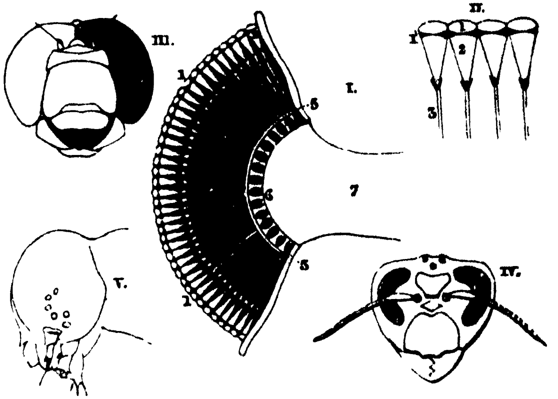

Fig. 5.—I. VERTICAL SECTION OF THE EYE OF AN INSECT. II. THE LENSES AND CONES ENLARGED. III. FRONT OF HEAD OF DRAGON-FLY, SHOWING THE POSITION OF THE COMPOUND EYES. IV. FRONT OF HEAD OF WASP, SHOWING THREE SIMPLE AND TWO COMPOUND EYES. V. SIDE OF CATERPILLAR'S HEAD, WITH SIX EYES.

Ref. to Nos. in Figs. I., II.—1, surface lens; 1', layer of pigment (iris); 2, cone, vitreous humour; 3, special optic nerve; 4, common pigment; 5, common retina; 6, secondary optic nerves; 7, main nerve.

The simple eyes of insects seem to be used for distant objects, for if these be painted over with red sealing-wax dissolved in strong spirit, so as to blind them, the insect has no power of directing its flight, but towers straight upward towards the sky. The curious compound eyes must be used, therefore, for near objects, and as they stretch round the head and look every way, they must save the insect much trouble in turning the head as it runs in and out the bells and tubes of flowers searching for honey and pollen.

Lobsters and crabs, belonging to another order of animals with jointed limbs, have very similar eyes, but the facets are often square, and not six-sided; the conical lens, too, is not convex on its outer surface.

This kind of eye, however, is by no means found in all animals of this sub-kingdom. The whole tribe of spiders has only simple eyes; but there are usually eight of them set in two rows on the front part of the head.

Among the animals of lower grade than those of the soft slug-like and the jointed sub-kingdom, a number of grades in the development of the organ of vision have been discovered. In many of them specks of colour with a nerve running to them are found; but as we cannot ask these animals what their sensations are, and their intelligence is of so low an order that we can infer but little from their movements, we can only conjecture them to be eyes.

Thus, the star-fish has specks at the ends of its rays which serve as elementary optic organs. The great floating jelly-fish, which, as it is seen from a ship, reminds one of an animated umbrella, has specks round the edge, where the whalebone knobs should be. All these and a thousand other structures seem, from the experiments that have been made, to serve as organs for perceiving light; but probably the impressions they receive are as faint and dull compared to the vivid pictures presented to the sense of the higher animals, as the information which light brings to the infant, whose eye is not yet sufficiently educated to guide its wandering hands, is crude when compared with the ideas which are presented to the mind of a man by means of wondrous light, its marvellous recipient—the eye, and its yet more marvellous interpreter—the mind

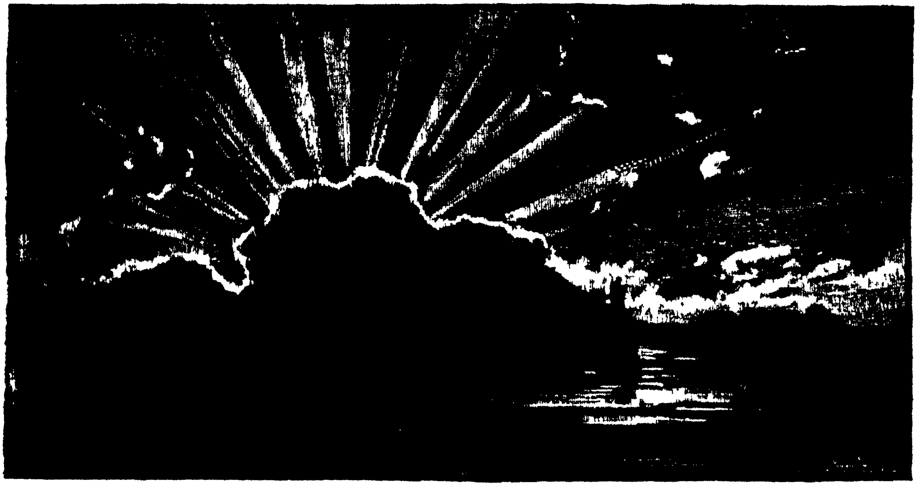

Fig 11

LIGHT.—II.

[*Continued from p.* 121.]

THE MOTION OF LIGHT IN STRAIGHT LINES.

In its spread light proceeds in straight lines, and only under circumstances well known is its course curved or crooked. Proofs innumerable of this present themselves in every-day life. The sun is hidden behind a bank of cloud; its rays spread outwards in perfectly straight lines (Fig. 11). A beam enters a dark room through a chink in its closed shutters; it passes across in an undeviating straight path, like the line of duty. The very existence of shadows is a consequence of light proceeding in straight lines; if light could get round corners, shadows would have no existence. The earth in revolving on its axis presents one hemisphere to the sun during part of the day; the other half is in shadow.

IMAGES WITHOUT GLASSES OR LENSES.

Make a cardboard tube, say, about 12 inches long and 2 inches in diameter. Fit into it a lesser one, which will slide easily in and out. Let the inside of each tube be blackened Over one end of this arrangement fix a cover of tinfoil; and similarly, over the outer end of the other tube, a covering of tracing-paper, as in Fig 12 Prick a hole into the centre of the tinfoil with a pin, and now bring a candle opposite the pin-hole Slowly slide out the inner tube; a fairly good image of the candle appears on its tracing-paper end, and it varies in size with the distance of the tracing-paper from the pin-hole; further, the image is upside down. On the assumption that light travels in straight lines, this is quite easy to understand. Thus, the candle *c* sends its light through the pin-hole *p* in

Fig 12

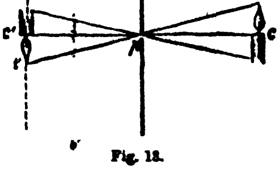

Fig. 13.

such a manner that a ray from the tip of the flame *t* falls on the tracing-paper screen at *t′*, and the base of the flame falls on *c′*; in other words, the image is inverted. Again, from the same diagram, it will be seen that if the screen approach the pin-hole to the position *a′ b′*, then the image must decrease in size; such is the case. Therefore, the phenomena of the pin-hole camera prove that light proceeds in straight lines.

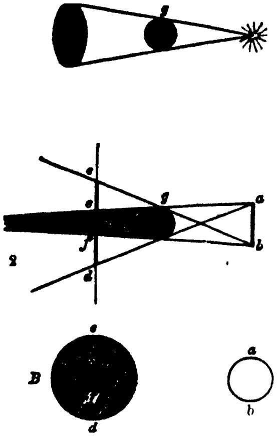

Fig. 14.

An interesting example of the rectilineal course taken by light may sometimes be seen while walking under the leafy branches of a tree. On the pathway a number of circular spots of light appear, which wave about with the movement of the leaves in the breeze. They are images of the sun. The shade afforded by the spreading branches may be so complete that no direct sunlight reaches the footpath, or here and there the sun's rays may find their way through in a direct way to the ground, and it is in such cases that solar images are formed. The sunbeams pass through the irregular leafy apertures, cross each other and make images in a very similar manner to what obtains in the pin-hole camera, save that in this instance we have the overlapping of a great number of images.

SHADOWS.

A shadow is the comparative absence of light. An area is illuminated; it encloses one which is less illuminated. The latter constitutes a shadow. It may be the shadow of a cloud passing slowly over a sunlit landscape, or simply grotesque shapes resulting from the shadow of the hands on the gas-illumined wall.

Here let us consider the shadow of an opaque body—say, a cricket-ball *g*—cast (1) by a point of light *p* (Fig. 14), and (2) by a large surface of light *a b*. In the first case, the shadow is sharply defined, as at A. In the second case, however, there is a ring of fringe, or border, which is less dark than the central body of shadow; it is the *penumbra*, or partial shadow. The diagram will make it clear how this occurs. Let *a* and *b* represent two points in the illuminating body; the point of light *a* would give a perfect shadow *c d*, and, on the other hand, the point of light *b* would give a perfect shadow *e f*; *c f*, the part in common, is in perfect darkness, but the space *e c* is lighted up by *a*, and the space *f d* is illuminated by *b*. The result is shown at B.

With a paraffin-oil lamp or gas flame, a small opaque body, and a sheet of white paper, disposed in the respective positions *a b*, *g*, and *e d*, one may with a little adjustment get the *umbra*, or true shadow, and also the penumbra.

One of the biggest of shadows is that presented in an eclipse of the moon, when this satellite enters the long cone of darkness which exists on the side of the earth opposite the sun. The sun, as an enormous disc of light, creates a penumbra which surrounds the true shadow. This is shown in Fig. 15.

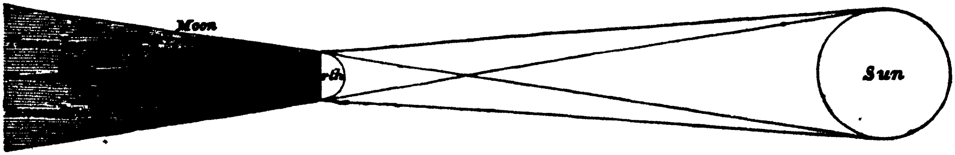

Fig. 15.

One of the minutest of shadows is seen in the so-called "Purkinje's figures." Here microscopic vessels of the eye cast their shadows on a sensitive part, and are seen as a dark network on a red ground. Thus you may see them:—Go into a dark room with a candle; close one eye, and stare into the darkness with the other, while you move the candle up and down just off one side of the open eye. "Purkinje's figures" will soon make themselves apparent.

Condensed steam floating in the air, mist, and white cloud, all so closely akin, may be illumined as conspicuously as a solid area; it follows, therefore, that it will form as efficient a background of shadow. Thus it happens that, with the sun overhead and an expanse of cloud beneath, aëronauts often see shadows of themselves and car surrounded by a rainbow halo. The circumstances are similar, and the phenomenon also, to those presented in the Harz Mountains by the Spectre of the Brocken.

Before the mist has been quite dispelled by the rising sun, travellers on other lofty heights besides the Brocken have often recorded that they have seen gigantic shadows of themselves in the west, which have repeated their every movement.

LIGHT IS ENFEEBLED BY DISTANCE.

One of the simplest proofs that light is enfeebled by distance is afforded by the fact that the reader may peruse this page by the light of a single candle, and that if he go a yard or two away, he cannot read it with the same ease. If the distance be increased still more, the light yielded is now altogether too feeble for him to read the page at all. With increase of distance from the candle, there is very evidently a rapid decrease in the amount of light cast upon any given area.

This diminishing of the illuminating power of a light with distance conforms to a definite law, generally known as the *law of inverse squares*. Thus, if we call the quantity of light falling upon the page of our book 1 unit of light when a yard from the candle, then at a distance of two yards the quantity will be one-fourth of a unit, and at three yards away, one-ninth of a unit—the inverse of the squares of 1, 2, and 3.

A geometrical proof of this law is obtained on considering the relative superficial areas of a number of spheres, or globes, of 1, 2, 3, etc., units of length from the centre to the surface. For if *c* (Fig. 16) be a point of light, it is evident that its light in spreading out in every direction would illuminate the surface of a sphere with a radius *c a*; and, in spreading further outwards, the same quantity of light would also spread over the surface of a sphere with a length of radius *c b*, which is twice *c a*; but the area of the surface of this second sphere is 4 times that of the one with radius *c a*, and the light is, therefore, spread over 4 times the ground, and is enfeebled to that extent. Similarly, a sphere with a radius *c d*, which is 3 times *c a*, has 9 times the superficial area of the least one; and consequently, at point *d*, the light from *c* is 9 times less in quantity than at *a*.

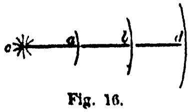

Fig. 16.

ON LIGHT-MEASURING.

By making use of the law of inverse squares, one can ascertain the relative illuminating powers of two lights. Take two lights—say, a paraffin-oil lamp and a candle—and let them cast shadows of the same object on to a white wall or a screen, as in Fig. 17. A convenient object is a stick put into the mouth of a bottle. It will be observed at first that one of the shadows is much darker than the other. Gradually increase the distance of one of the lights from the wall until the two shadow have both the same degree of darkness. Measur the distances of the lights from the wall, and squar the numbers—*i.e.*, multiply each number by itself

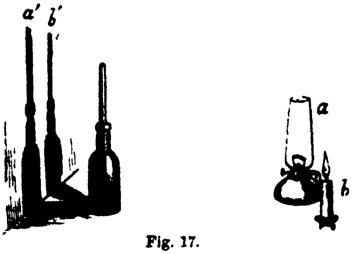

Fig. 17.

thus, if the candle be 4 feet from the wall, and the lamp 6 feet away, we get the numbers $4 \times 4 = 16$ and $6 \times 6 = 36$. Now these two shadows of the stick are illuminated by the two sources of light; thus, the lamp *a* illuminates the shadow *b′*, and the candle *b* illuminates the shadow *a′*. Seeing that both shadows are of equal intensity, it follows that they are illuminated by equal quantities of light—*i.e.*, $\frac{1}{16}$th the light of the candle is equal to $\frac{1}{36}$th the light of the paraffin-oil lamp, and their relative illuminating power is as 16 to 36; in other words, the paraffin-oil lamp is equal to $\frac{36}{16} = 2\frac{1}{4}$ candles.

An arrangement of this kind for ascertaining the relative illuminating power of two lights is called a *photometer*, which means *light-measurer*. This shadow device is known as Rumford's photometer.

BUNSEN'S PHOTOMETER (Fig. 18).

Light may also be measured by means of a grease spot. Take a piece of white blotting-paper, and touch it with butter; warm until the grease spot has spread out into a translucent circle. Now, if the paraffin-oil lamp and the candle be placed 4 or 5 feet apart, and the grease spot be moved between them, backwards and forwards, it will be seen that when the spot is brought near one of the lights, and it is regarded from that side, it has quite a dark appearance on the white background of paper; whereas upon looking at the spot from the other side, it has a bright appearance from the transmitted light. There is a point, however, between the two lights, at which the grease spot appears neither darker nor lighter than the remainder of the paper—in short, it disappears; and when this is the case it is being illuminated by an equal quantity of light from each source. Therefore, if the distances of the lamp and candle from the grease spot be carefully measured and squared, we get the data for a comparison of their illuminating powers. Thus, let us suppose that the two lights are 10 feet apart, and that upon moving the grease spot backwards and forwards between them we find the point of its disappearance to be 4 feet from the candle and 6 feet from the lamp, we then employ these figures as in the case of the Rumford photometer. The grease-spot device is known as the Bunsen photometer.

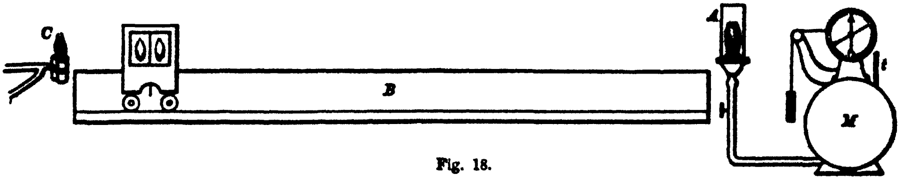

Fig. 18.

HOW THE ILLUMINATING POWER OF GAS IS

The illuminating power of coal-gas is obtained with a Bunsen photometer; and it will be of interest here to inquire how the figures are usually got which appear regularly in the papers as the illuminating power of the gas supplied by corporation or company. We enter the gas-examiner's room, and find, in the first place, that it is black-washed—*i.e.*, the walls are of a dull black, so as not to reflect light. On a long table we observe an arrangement of apparatus, part of which is shown in Fig. 18. The meter M supplies the gas to the Argand burner A, where it is consumed at a definite rate, viz., 5 cubic feet per hour. A couple of candles at C are suspended from one of the arms of a balance, and here the quantity of candle burned in a given time can be ascertained. The candles are sperm candles, and ought each to burn at the rate of 120 grains per hour. Suppose both candles and gas are burning in the needful manner, a greased disc of paper is moved along the bar B until the grease spot vanishes. This bar is usually graduated in such a manner that the illuminating power of the gas is obtained at a glance. The greased disc is fixed in a box D, to which the light from candles and gas has access from opposite sides; and as the observer stands in front of it, a couple of reflectors inside show when the grease spot is illuminated equally from each source. The box moves on small wheels, and a pointer between them indicates the figure arrived at when the grease spot vanishes. Once every minute, for ten minutes, an observation is made, and the average is taken. Corrections have to be introduced for the temperature of the gas, taken with the thermometer *t*; for the atmospheric pressure, ascertained with a barometer; and then the examiner finds what is the illuminating power of the gas—*i.e.*, how many sperm candles it is equal to. The operation is a comparison of the candle and gas-flame, and serves as an illustration of a technical use of the grease-spot disc.

THE SPEED OF LIGHT.

Light travels at an enormous speed. Ordinary standards of high speed are creeping paces by the side of it. An express train rushing along at 60

than 30 yards in a second; in this same second light travels 190,000 miles! The motion of a cannon ball is slow beside it; and, indeed, its speed is so very great that it lends itself to many startling comparisons. Thus, according to Sir John Herschel, "a cannon ball would require 17 years to reach the sun, yet light travels over the same space in eight minutes. The swiftest bird at its utmost speed would require nearly three weeks to make the tour of the earth. Light performs the same distance in much less time than it is necessary for a single stroke of its wing; yet its rapidity is but commensurate with the distance it has to travel. It is demonstrable that light cannot reach our system from the nearest of the fixed stars in less than five years, and telescopes disclose to us objects probably many times more remote."

THE FIRST ATTEMPTS TO MEASURE THE SPEED OF LIGHT FAILED.

The ancients had no conception of the speed of light. It was contended by Alhazen that light is not transmitted instantaneously; but in later times Porta undertook to prove that the passage of light is really instantaneous. Their confusion may be well excused, for mankind had then no idea of any velocity so great as that of light proved to be. Galileo attempted to measure its speed, but failed. He had two men with lights, a distance apart, one of whom was to observe when the other uncovered his light, and exhibit his own the moment he saw it; the more perfectly two such experimenters worked with this method the more simultaneous would their actions appear. Galileo was, of course, disappointed in the results obtained, although, with his usual originality, he appears to have been the first to make any attempt to measure the velocity of light, after it had been thought for ages that its transmission was instantaneous. His observers were about a mile apart; and the experiments were afterwards carried on by that famous Italian scientific society, the Accademia del Cimento, with a distance of two miles between the observers. These experiments were also unsuccessful.

HOW THE SPEED OF LIGHT WAS FIRST ASCERTAINED.

Between the years 1670 and 1675 observations were being made on the eclipses of Jupiter's four moons, at the observatory of the Royal Academy of Sciences at Paris. The moons appeared to be irregular in their period of revolution around the planet, as measured by their eclipses. The first moon, for example, sometimes emerged exactly at the time calculated, and was sometimes unpunctual to the extent of 14 minutes! Thus, on November 9th, 1676, this satellite came into view 10 minutes later than it had been observed in the month of August, when the earth was much nearer Jupiter. The astronomers Cassini and Roemer both agreed that, to account for this peculiar phenomenon, it was necessary to suppose that light takes 14 minutes to cross the earth's orbit. Cassini published this idea in 1675, but subsequently abandoned it; Roemer, however, stuck to the hypothesis, and so strenuously maintained it against all opposition, that he is generally credited with the discovery of the velocity of light by this method (Fig. 19).

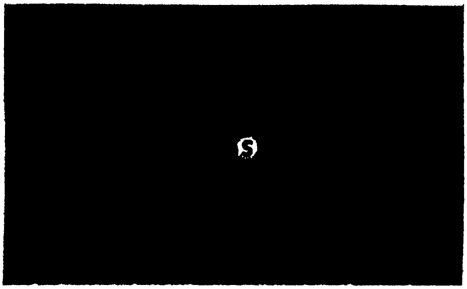

Fig. 19.

This discovery, then, amounted to this—that when the earth was in the positions E and F with respect to the sun S and Jupiter J, an eclipse of a moon at Jupiter is seen 15 minutes later when the earth is at F, than when it is at E; and, consequently, that the light must have taken 15 minutes to cross from E to F. This distance being approximately ascertained, and the necessary calculation made, gives for light a velocity of 192,500 miles per second! This speed is comparable with no other that we know of save that of the electric current, which rushes along at about the same rate.

LATIN.—XXXIX.

[Continued from p. 129.]

LATIN READINGS (*continued*).

LIVY.

Our second extract is part of the account of a deed of bravery that is no doubt well known to most of our readers, the defence of the bridge by Horatius Cocles, which forms the subject of the best of Macaulay's "Lays of Ancient Rome." The last of the kings of Rome, Tarquinius Suberbus, who had been driven from the state for his great cruelties, made several vigorous efforts to regain the crown he had lost. He summoned to his aid Porsenna, lord of the neighbouring state of Clusium, who came with a strong army to attack Rome. The only hope for the Romans lay in breaking down the bridge over the Tiber, and so preventing the entrance of Porsenna's army, but the enemy were close upon them before they accomplished their object. In this juncture a brave Roman, named Horatius, volunteered to keep the passage of the bridge, with two of his friends, until the Romans should be able to cut it down:—

LIVY, II. 10, 5.

Vadit inde (Horatius) in primum aditum pontis, insignisque inter conspecta cedentium pugnae terga obversis comminus ad ineundum proelium armis ipso miraculo audaciae obstupefecit hostes. Duos tamen cum eo pudor tenuit Sp. Lartium ac T. Herminium ambos claros genere factisque. Cum his primam periculi procellam, et quod tumultuosissimum pugnae erat, parumper sustinuit: deinde eos quoque ipsos exigua parte pontis relicta, revocantibus qui rescindebant, cedere in tutum coegit. Circumferens inde truces minaciter oculos ad proceros Etruscorum, nunc singulos provocare, nunc increpare omnes servitia regum superborum suae libertatis immemores, alienam oppugnatum venire. Cunctati aliquamdiu sunt, dum alius alium ut proelium incipiant, circumspectant. Pudor deinde commovit aciem, et clamore sublato indigne in unum hostem tela conjiciunt. Qua quum in objecto cuncta scuto, haessisent, neque ille minus obstinatus ingenti pontem obtineret gradu, jam impetu conabantur detrudere virum, quum simul fragor rupti pontis, simul clamor Romanorum alacritate perfecti operis sublatus, pavore subito impetum sustinuit. Tum Cocles, "Tiberine pater," inquit, "te sancte precor, haec arma et hunc militem propitio flumine accipias." Ita sic armatus in Tiberim desiluit, multisque super incidentibus telis incolumis ad suos tranavit, rem ausus plus famae habituram ad posteros quam fidei. Grata erga tantam virtutem civitas fuit; statua in comitio posita, agri quantum uno die circumaravit datum.

NOTES.

Cedentium pugnae, "retreating"; literally, "yielding to the battle."

Et quod, etc., "the most tumultuous part of the fray."

Revocantibus, etc., "while they who were cutting down the bridge were calling them to come back."

Etruscorum. Clusium, whence Porsenna came, was a city of Etruria.

Provocare—increpare, historical infinitives.

Servitia, put for *servos*, the abstract for the concrete. So we find *militia* for *milites; juventus* for *juvenes*. To agree with it Livy puts *immemores*, a *constructio κατὰ σύνεσιν* (according to the sense).

Suae libertatis, etc. The infinitive *venire* depends upon the verb *increpare*; "taunting them for coming, slaves of a proud king as they were, and careless of their own freedom, to attack the freedom of others"

Oppugnatum, supine in -um, after *venire*, a verb of motion.

In unum hostem, "on their solitary foe."

Conabantur, etc., *hostes*, "when the darts had stuck fast the enemy (who had thrown them) endeavoured."

Plus famae, etc., "destined to gain among posterity more fame than credit."

Comitio. The *comitium*, the place of meeting of the *comitia*, or public assemblage, was part of the Forum

In the course of a war (B.C. 319) with the Samnites, a people who inhabited the country north of Campania, the Roman army were entrapped in a narrow defile called the Furculae Caudinae, or Caudine Forks, and were obliged to surrender. The following extract is remarkable as being one of the few descriptions of scenery found in Latin literature:—

LIVY, IX. 2, 4

Duae ad Luceriam ferebant viae altera praeter oram superi maris patens apertaque sed quanto tutior tanto fere longior, altera per Furculas Caudinas brevior. Sed ita natus locus est: saltus duo alti angusti silvosique sunt montibus circa perpetuis inter se juncti: jacet inter eos satis patens clausus in medio campus herbidus aquosusque, per quem medium iter est: sed ante quam venias ad eum, intrandae primae angustiae sunt, et aut eadem, qua te insinuaveris, retro via repetenda, aut si ire porro pergas, per alium saltum arctiorem impeditioremque evadendum. In eum campum via alia per cavam rupem Romani remisso agmine, quoniam ad alias angustias protinus pergerent, septas dejectu arborum saxorumque ingentium objacentem molem invenere. Quum fraus hostilis apparuisset, praesidium etiam in summo saltu conspicitur: citati inde retro, qua venerant, pergunt repetere viam: eam quoque clausam sua obice armisque inveniunt.

NOTES.

Superi maris, the Adriatic, which lies to the north-east of Italy, and so above it, as opposed to the *mare inferum*, or *Tyrrhenum*, which lies to the south-west.

Quanto tutior, etc. In a comparison of two qualities which are found in the same thing in an unequal degree, the one varying with the other, the Latins use two comparatives; we use the positive. Literally, "as long as it was secure, its length being proportionate to its security."

Ita natus, "the nature of the spot is as follows."

Satis patens, "of tolerably wide extent."

Venias—i.e., "you, the reader."

Cavam rupem, "through a rocky gorge."

Protinus pergerent, "had got right through to the defile at the other end."

Dejectu arborum, put for *dejectis arboribus*.

Conspicitur, the change to the present adds vividness and force to the description

Sua, "with its barrier," just like the other.

CICERO.

The literature of Rome culminates in Marcus Tullius Cicero, who lived from B.C. 106 to B.C. 43. Both as an orator and a philosopher Cicero attained to the highest point of excellence, and as a writer of letters he is without a rival. With his achievements as a statesman we have little to do in this place, but it may be at least noticed that he took an active part in political affairs, and at least on one occasion (the conspiracy of Catiline, the merit of the discovery and suppression of which fairly rests with him alone) was in a literal sense the "saviour of his country." The part which he subsequently played in the civil wars between Pompey and Cæsar does not greatly redound to his credit, and he showed himself weak and vacillating. Probably he was too much of a philosopher to be a man of energetic action when the right path was difficult to discover, and in each of the great political parties Cicero must have seen much that was revolting. Still, one forgets much of his weakness in his tragical end; and his murder, which was an act of stupid, unreasoning cruelty, must remain for ever a dark blot on the policy of those who dictated it. It is by his writings that Cicero will best be remembered. Treatises on philosophy, speeches forensic and judicial, and letters innumerable flowed from his pen, and happily the greater part of them have been preserved to our own times. He left to others the writing of history; but his short essay, "De Republicâ," shows that he had an intimate and critical acquaintance with the history of his country, and a sound knowledge of the political principles on which the Roman Constitution had been built up. His style has always been allowed to be perfect, "Ciceronian" Latin having passed into a proverb; and it is the ideal to which all the writers of Latin prose in the Middle Ages and subsequently have endeavoured to attain. It is distinguished by its simple elegance and singular absence of mannerism; the words are selected and the sentences constructed

and balanced with a careful attention to the laws of rhythm and harmonious propriety, which, in a writer so voluminous, may well excite our astonishment and challenge our imitation. In the extracts given below we have endeavoured to give the reader a specimen of Cicero's powers in each of the branches of literature in which he chiefly distinguished himself (philosophy, oratory, and letter-writing), though our space is far too limited to allow us to do anything like justice either to the quantity or the quality of his writings. Cicero's philosophical works, always faultlessly written, contain, every now and then, passages of singular beauty. The following eloquent apostrophe to philosophy, taken from the "Tusculan Disputations" (a series of imaginary discourses and conversations held at his villa at Tusculum), has always been greatly admired —

CICERO.—"TUSC. DISP.," V. 2.

Sed et hujus culpae, et ceterorum vitiorum peccatorumque nostrorum omnis a philosophia petenda correctio est: cujus in sinum cum a primis temporibus aetatis nostrae voluntas studiumque nos contulisset, his gravissimis casibus in eundem portum, ex quo eramus egressi, magna jactati tempestate confugimus. O vitae Philosophia dux! O virtutis indagatrix, expultrixque vitiorum! quid non modo nos, sed omnino vita hominum sine te esse potuisset? tu urbes peperisti; tu dissipatos homines in societatem vitae convocasti; tu eos inter se primo domiciliis, deinde conjugiis, tum literarum et vocum communione junxisti; tu inventrix legum, tu magistra morum et disciplinae fuisti: ad te confugimus, a te opem petimus: tibi nos, ut antea magna ex parte, sic nunc penitus totosque tradimus. Est autem unus dies bene et ex praeceptis tuis actus, peccanti immortalitati anteponendus. Cujus igitur potius opibus utamur quam tuis? quae et vitae tranquillitatem largita nobis es, et terrorem mortis sustulisti? Ac Philosophia quidem, tantum abest, ut proinde ac de hominum vita est merita, laudetur; ut, a plerisque neglecta, a multis etiam vituperetur. Vituperare quisquam vitae parentem, et hoc parricidio se inquinare audet? Et tam impie ingratus esse, ut eam accuset, quam vereri deberet, etiam si minus percipere potuisset?

NOTES.

Hujus culpae. The error, to which Cicero had just before alluded, of magnifying and exaggerating our misfortunes.

His—casibus. He probably alludes to Cæsar's death, or perhaps more generally to the civil wars of the period.

Eundem portum, etc. Philosophical retirement and contemplation.

Peccanti immortalitati, "an eternity of sin." The reader will perforce be reminded of the more pious ejaculation of the Psalmist, "One day in thy courts is better than a thousand."

Tantum abest, ut, etc. "Is so far from being praised as it deserves, that it is even railed at."

Hoc parricidio. "By the guilt of such a parricidal act."

The following extract is the vigorous commencement of the first of Cicero's speeches against Catiline, the story of whose conspiracy, and its detection by Cicero, we have already given in our extracts from Sallust's account of the transaction. In spite of the fact that his treason was well known, Catiline still had the audacity to appear in the Senate; and it was while he was sitting there that Cicero attacked him in the following indignant words:—

CICERO.—"IN CATILINAM," I. 1.

Quo usque tandem, Catilina, abutere patientia nostra? Quamdiu etiam furor iste tuus nos eludet? Quem ad finem sese effrenata jactabit audacia? Nihilne te nocturnum praesidium Palatii, nihil urbis vigiliae, nihil timor populi, nihil concursus bonorum omnium, nihil hic munitissimus habendi senatus locus, nihil horum ora vultusque moverunt? Patere tua consilia non sentis? Constrictam omnium horum scientia teneri conjurationem tuam non vides? Quid proxima, quid superiore nocte egeris, ubi fueris, quos convocaveris, quid consilii coeperis, quem nostrum ignorare arbitraris? O tempora! O mores! senatus haec intelligit: consul videt: hic tamen vivit. Vivit? immo vero in senatum venit, fit publici consilii particeps: notat et designat oculis ad caedem unumquemque nostrum. Nos autem, viri fortes, satisfacere rei publicae videmur, si istius furorem ac tela vitemus. Ad mortem te, Catilina, duci jussu consulis jam pridem oportebat; in te conferri pestem quam tu in nos omnes jamdiu machinaris. An vero vir amplissimus P. Scipio, pontifex maximus, Ti. Gracchum mediocriter labefactantem statum rei publicae privatus interfecit. Catilinam orbem terrae caede atque incendiis vastare cupientem, nos consules perferemus. Nam illa nimis antiqua praetereo, quod C. Servilius Ahala Sp. Maelium novis rebus studentem manu sua occidit. Fuit, fuit ista quondam in hac re publica virtus, ut viri fortes acrioribus suppliciis civem perniciosum quam acerbissimum hostem coercerent. Habemus senatus consultum in te, Catilina, vehemens et grave, non deest rei publicae consilium atque auctoritas hujus ordinis: nos, nos, dico aperte, consules desumus.

NOTES.

Tandem. "To what length will it go; when will it cease?"

Quamdiu etiam. "How long still?"

Palatii, the ascent to the Palatine Hill from the Via Sacra had been occupied by an armed force.

Munitissimus. "Most strongly defended."

Habendi senatus. The participle in *-dus* agreeing with the noun,

in preference to the gerund governing the noun—*habendi senatum.*

Constrictam. "Stifled, restrained."

Proxima. The speech was delivered on the 8th of November; on the 6th *superiore* (= *priore*) a meeting of the conspirators had been held at the house of M. Læca.

O tempora, etc. The degeneracy of the age consisted in the fact that Catiline could still show his face without danger of being put to death.

P. Scipio. This was P. Scipio Nasica Serapio, Pontifex Maximus, who led the rout that attacked Ti. Gracchus, and killed him, B.C. 133.—*Long.*

Mediocriter, etc. "Who was only sapping the foundations of the State, to a moderate extent."

Privatus—consules. "If he did this as a private man, how much more should we, who are the constituted authorities, act in a similar way in this case?"

C. Servilius Ahala. Ahala killed Mælius because he refused to obey the orders of the dictator Cincinnatus.—*Long.*

Studentem. *Studeo*, with acc., means "to study"; with dat. "to be bent upon," "to aim at." *Novis rebus*, "a revolution."

Senatus consultum. This was a decree passed on the 21st of October previous, by which the consuls received authority to employ force of arms.—*Long.*

Hujus. The senatorial order."

KEY TO HORACE.

"ODES," I. v.

What slender youth, bedewed with liquid odours,
Courts thee on roses in some pleasant cave,
    Pyrrha? For whom bind'st thou
      In wreaths thy golden hair,

Plain in thy neatness? Oh, how oft shall he
On faith and changèd gods complain, and seas
    Rough with black winds and storms
      Unwonted shall admire,

Who now enjoys thee credulous, all gold,
Who always vacant, always amiable
    Hopes thee, of flattering gales
      Unmindful? Hapless they

To whom thou untried seem'st fair. Me in my vowed
Picture the sacred wall declares to have hung
    My dank and dropping weeds
      To the stern god of sea.—*Milton.*

KEY TO LIVY, I. 13.

At this juncture the Sabine women, from the outrage on whom the war originated, with hair dishevelled and garments rent, the timidity of their sex being overcome by such dreadful scenes, had the courage to throw themselves amid the flying weapons, and making a rush across, to part the incensed armies, and assuage their fury; imploring their fathers on the one side, their husbands on the other, "that as fathers-in-law and sons-in-law they would not contaminate each other with impious blood, nor stain their offspring with parricide, the one their grandchildren, the other their children. If you are dissatisfied with the affinity between you, if with our marriages, turn your resentment against us; we are the cause of war, we of wounds and of bloodshed to our husbands and parents. It were better that we perish than live widowed or fatherless without one or other of you." The circumstance affects both the multitude and the leaders. Silence and a sudden suspension ensue. Upon this the leaders come forward in order to concert a treaty, and they not only conclude a peace, but form one state out of two. They associate the regal power, and transfer the entire sovereignty to Rome. The city being thus doubled, that some compliment might be paid to the Sabines, they were called Quirites, from Cures.

GERMAN.—XXXIX.

[*Continued from p.* 117.]

COMPOUND VERBS.

VARIOUS derivative verbs in German are produced by the union of simple words with prefixes. Under the name of *prefixes* are here comprehended all those invariable words (as adverbs and prepositions) which are combined with other words to vary or modify their signification. They are, also, often called *particles*. The simple words with which they are united are generally verbs; but often nouns and adjectives are, by prefixes, converted into verbs. Most of the prefixes are *separable*, that is, may stand apart from the radicals; some, however, are found to be *inseparable*; some are either separable or inseparable, according to circumstances.

The prefixes are themselves, also, either simple or compound, as, herkommen, to come *here* or *hither*; herüberkommen, to come *over here* or *hither*. In most instances the prefixes may be translated severally as above; but often they are found to be merely intensive or euphonic. This is, likewise, often the case in English; thus, *ex* (which, literally, signifies *out* or *out of*) has in some words the signification *very*, *exceedingly*, or the like, as, *exasperate*, to make *very* angry; so *a*, in the word *ameliorate*, is merely euphonic—the derivative form (ameliorate) meaning nothing more than the simple one, *meliorate*.

SIMPLE PREFIXES SEPARABLE.

Ab,	from, off, down;	Abſetzen, to set or put down; to depose.
An,	to, at, in, on, towards;	Anfangen, to catch at, *i.e.*, to begin.
Auf,	on, upon, up;	Aufgehen, to go up; to rise.
Aus,	out, out of, from;	Ausnehmen, to take out; to except.
Bei,	by, near, with;	Beiſtehen, to stand by, assist.
Da,	there, at;	Dableiben, to remain there, or at; to stay.
Dar,	there, at;	Darreichen, to reach there, *i.e.*, to offer.
Ein,	in, into;	Einkaufen, to buy in; to purchase.
Empor,	up, upward, on high;	Emporheben, to lift up.

Fort,	onward, away, forward;	Fortfahren, to drive away; to continue.
Gegen,	towards, against;	Gegenhalten, to hold against; to compare.
Heim,	home, at home;	Heimkehren, to turn homeward; to return.
Her,	hither, here;	Herbringen, to bring hither, or along.
Hin,	thither, there, away;	Hingehen, to go thither, or away.
Mit,	with;	Mitnehmen, to take with, or along.
Nach,	after;	Nachfolgen, to follow after; to succeed.
Nieder,	down, downwards, under;	Niederreißen, to pull down.
Ob,	on, over, on account of;	Obliegen, to lie on, *i.e.*, to apply oneself to; to be incumbent on.
Vor,	for, before;	Vorgehen, to go before; to precede.
Weg,	away, off;	Wegbleiben, to stay away.
Zu,	to, towards;	Zugeben, to give to; to grant.

COMPOUND PREFIXES SEPARABLE.

Anheim	(an + heim, to-home);	Anheimſtellen, to put home to, *i.e.*, to refer to.
Dabei	(da + bei, there-by);	Dabeiſtehen, to stand close by.
Dahin	(da + hin, there-thither);	Dahineilen, to hasten away.
Daran	(dar + an, there-to);	Daranſetzen, to put or lay thereto, *i.e.*, to risk, to stake.
Darein	(dar + ein, there-in);	Dareinreden, to talk therein, *i.e.*, to interrupt.
Davon	(da + von, there-from);	Davonlaufen, to run off, or away.
Dazu	(da + zu, there-to);	Dazuthun, to do (in addition) thereto; to add.
Dazwiſchen	(da + zwiſchen, there-between);	Dazwiſchenreden, to speak there in the midst.
Einher	(ein + her, into-hither);	Einherziehen, to draw along.
Entgegen	(ent + gegen, apart-towards);	Entgegengehen, to go towards; to go to meet.
Entzwei	(ent + zwei, apart-two);	Entzweibrechen, to break or burst asunder.
Herab	(her + ab, hither-down);	Herabſetzen, to put down; to lower.
Heraus	(her + aus, hither-out);	Herausfahren, to drive out.
Herbei	(her + bei, hither-along);	Herbeirufen, to call by or towards.
Hernieder	(her + nieder, hither-down);	Herniederblicken, to look down.
Herüber	(her + über, hither-over);	Herüberkommen, to come over.
Herum	(her + um, hither-around);	Herumgeben, to give or hand around.
Herunter	(her + unter, hither-under);	Herunterfahren, to drive down.
Hervor	(her + vor, hither-forward);	Hervortreten, to step forward.
Hinauf	(hin + auf, hither-on or up);	Hinaufziehen, to pull up.
Hinaus	(hin + aus, thither-out);	Hinauswerfen, to throw out.
Hinein	(hin + ein, thither-into);	Hineingießen, to pour into.
Hintan	(hint(en) + an, behind to);	Hintanſetzen, to put behind; to undervalue.
Hinüber	(hin + über, thither-over);	Hinübertragen, to carry over.
Hinunter	(hin + unter, thither-under);	Hinunterſpringen, to leap down.
Hinweg	(hin + weg, thither-away);	Hinwegnehmen, to take away.
Hinzu	(hin + zu, thither-towards);	Hinzueilen, to hasten towards.
Überein	(über + ein, over-into);	Übereinkommen, to come over into, *i.e.*, to agree.
Umher	(um + her, around-hither);	Umherſchauen, to gaze around.
Umhin	(um + hin, around-thither);	Umhinkönnen, to be able thereabout; to forbear.
Voran	(vor + an, before-to);	Voranſtellen, to place before.
Voraus	(vor + aus, before-out);	Vorausſehen, to see or spy out beforehand; to anticipate.
Vorbei	(vor + bei, before-by);	Vorbeireiten, to ride along before; to ride past.
Vorher	(vor + her, before-hither);	Vorherſehen, to foresee.
Vorüber	(vor + über, before-over);	Vorüberfahren, to drive along past in a coach.
Zuvor	(zu + vor, before-to);	Zuvorthun, to do before; to excel.
Zurück	(zu + rück, back-to);	Zurückkehren, to return.
Zuſammen	(zu + ſammen, to-gether);	Zuſammenſetzen, to put together.

PARADIGM OF A COMPOUND VERB SEPARABLE.

Anfangen, to begin.

IND. *Pres.* Ich fange an, du fängſt an, er fäng an; wir fangen an, ihr fangt an, ſie fangen an.—*Past.* Ich fing an, du fingſt an, er fing an; wir fingen an, ihr fingt an, ſie fingen an.—*Pres. Perf.* Ich habe angefangen; wir haben angefangen.—

Plup. Ich hatte angefangen; wir hatten angefangen.—*Fut. Imp.* Ich werde anfangen; wir werden anfangen.—*Fut. Perf.* Ich werde angefangen haben; wir werden angefangen haben

SUB. *Pres.* Ich fange an, du fangeſt an, er fange an; wir fangen an, ihr fanget an, ſie fangen an.—*Past.* Ich finge an, du fingeſt an, er finge an; wir fingen an, ihr finget an, ſie fingen an.—*Pres. Perf.* Ich habe angefangen; wir haben angefangen.—*Plup.* Ich hätte angefangen; wir hätten angefangen.—*Fut. Imp.* Ich werde anfangen; wir werden anfangen.—*Fut. Perf.* Ich werde angefangen haben; wir werden angefangen haben.

COND. *Fut. Imp.* Ich würde anfangen; wir würden anfangen.—*Fut. Perf.* Ich würde angefangen haben; wir würden angefangen haben.

IMP. *Pres.* Fange (du) an, fange er an; fangen wir an, fanget (ihr) an, fangen ſie an.

INF. *Pres.* Anfangen or anzufangen, to begin.—*Perf.* Angefangen haben, to have begun.—*Fut.* Anfangen werden, to be about to begin.

PART. *Pres.* Anfangend, beginning.—*Past.* Angefangen, begun.

OBSERVATIONS ON THE PARADIGM.

An inspection of the above paradigm will show that the separation of the prefix from the radical part of the verb takes place in the indicative, subjunctive, imperative, infinitive (when preceded by zu), and the perfect participle. In the indicative and subjunctive, however, the separation is *not* made when, in dependent sentences, the verb is placed at the end of a clause or period: thus, als die Sonne dieſen Morgen aufging, ſo verſchwand der Nebel, when the sun rose (aufging) this morning, the fog disappeared.

In regard to the *position* of the particle, when separated, it must be noted that in the indicative, subjunctive, and imperative, it stands *after* the radical; often, also, after the several words dependent upon it; thus, ich fange das Buch an (where an, belonging to fange, comes after the object), I begin the book.

In the infinitive and the perfect participle, on the contrary, the particle comes *before* the radical; being separated from it, in the *infinitive*, by zu (when that preposition is employed), and, in the *participle*, by the augment ge-, which is peculiar to that part of the verb; thus, anzufangen (an + zu + fangen), to begin, to commence; vorgeſtellt (vor + ge + ſtellt), placed before one, represented.

It remains to be added that particles, when separated from the radicals, receive the full or principal accent; and that the radicals (if verbs) have the same form of conjugation, old or new, regular or irregular, as when employed without prefixes.

INSEPARABLE PREFIXES.

The prefixes of this class, as the name implies, are always found in close union with their radicals. They allow not even the augment syllable ge-, in the perfect participle, to intervene, but reject it altogether (from this, however, must be excepted the case of the prefix miß, which, in a few instances allows the augment ge- to be *prefixed*—thus, from mißdeuten, to misinterpret, we have, in the perfect participle, gemißdeutet); as, bedeckt (not gebedeckt), covered, from bedecken, to cover. Neither is zu (when used) allowed to come between the prefix and the infinitive, but stands before the two combined into one word; as, zu empfangen (not empzufangen), to receive; except in case of compound prefixes, wherein the first component is a separable and the second an inseparable particle, zu being then inserted between the two particles, as, anzuerkennen (from anerkennen). The inseparable prefixes are always unaccented, except after and miß.

SIMPLE PREFIXES INSEPARABLE.

After,	after, behind;	Afterreden, to talk behind (one's back); to slander.
Be,	near, by, over, to make;	Bekommen, to come by, *i.e.*, to get; to obtain.
Emp,	in, within;	Empfinden, to find *or* feel within; to perceive.
Ent,	apart, away, to deprive of;	Entgehen, to go away *or* off; to escape.
Er,	forth, for, on behalf of;	Erklären, to make clear for (*one*); to explain.
Ge,	(mainly *intensive* or *euphonic*):	Gedenken (same as denken), to think of.
Miß,	wrong, erroneously;	Mißdeuten, to misinterpret.
Ver,	away, at a loss;	Verſchlafen, to sleep away, *i.e.*, lose by sleeping.
Wider,	against;	Widerſtehen, to stand against; to resist.
Zer,	apart, asunder;	Zerſchneiden, to cut apart *or* in pieces.

VERBS WITH INSEPARABLE PREFIXES DERIVED FROM COMPOUND NOUNS.

Beanſpruchen, to claim, lay a claim to anything.

Beaufſichtigen, to inspect, control.

Beauftragen, to commission.

Verabreden, to concert, agree upon.

Verabſcheuen, to abhor, detest.

Verabſchieden, to send away, dismiss.

Veranlaſſen, to occasion, cause.

Verausgaben, to spend, pay away.

OBSERVATIONS.

Be has in German the same power which it has in English. It is therefore, in most cases, better *transferred* than *translated*. Its uses will be easily learnt from examples. Thus, from

Klagen, to moan.	Beklagen, to *be*moan.
Streuen, to strew.	Beſtreuen, to *be*strew.
Lachen, to laugh.	Belachen, to laugh at.
Flügel, a wing.	Beflügeln, to furnish with wings, to hasten.
Glück, happiness.	Beglücken, to make happy.
Frei, free.	Befreien, to set free.

In some instances it is merely *euphonic*.

Emp and ent. Emp is, probably, only another form of ent; occurring, however, only in three verbs (empfinden, to feel; empfangen, to receive; empfehlen, to recommend), and bearing a sense but remotely related to its original. The prime and predominant power of ent is that of indicating *separation*, *departure*, *privation*.

In some instances it has the kindred sense of *approach* or *transition* from one point or condition towards another. For example:—

Gehen, to go.	Entgehen, to get off, escape.
Ziehen, to draw.	Entziehen, to withdraw.
Haupt, the head.	Enthaupten, to deprive of the head, to behead.
Kraft, power.	Entkräften, to deprive of power, to weaken.
Blöde, dim-eyed, dull, bashful.	Entblöden, to divest of shame, to be bold.
Sprechen, to speak.	Entſprechen, to answer *or* correspond to.

Ent is sometimes, also, merely *intensive* or *euphonic;* as, entleeren (from leer, *empty*), to empty out.

Er and ver. Er, as a general rule, conveys the idea of *getting* or *gaining for* someone, by means of that which is expressed by the word connected with it; as, erbitten, to get, or try to get by begging. It finds its exact opposite in ver, which marks what is *against* or *away* from someone's interest or benefit; as, verbitten, to beg off, to decline. The force and use of these particles are best illustrated by examples:—

Finden, to find.	Erfinden, to find out for oneself, invent.
Stehen, to stand.	Erſtehen, to arise, originate.
Bauen, to build.	Erbauen, to erect, to produce.
Spielen, to play.	Verſpielen, to play away, to lose by gambling.
Führen, to carry, or lead.	Verführen, to lead away, to seduce.
Salzen, to salt.	Verſalzen, to oversalt, spoil in salting.

Er and ver are also both employed in converting nouns and adjectives into verbs expressive of *transition* from one state or condition into another. Thus:—

Erkalten, (kalt, cold) to get cold.	Veredeln, (edel, noble) to ennoble.
Erkühnen, (kühn, bold) to become bold, dare.	Vergöttern, (Gott, God) to deify.
Erlahmen, (lahm, lame) to become lame.	Veralten, (alt, old) to grow old or obsolete.

In some instances, moreover, er and ver are only *euphonic* or *intensive*.

PREFIXES SEPARABLE AND INSEPARABLE.

The prefixes of this class, when separable, are always under the full accent; when inseparable, the accent falls upon the radical.

Their effect, *when separable*, is, in union with radicals, to produce certain *intransitive* compounds, in which each of the parts (prefix and radical) has its own peculiar and natural signification.

There are, however, some compounds of durch and um in which, though these particles are separable, the verbs are, nevertheless, transitive. Still, it will be found that in such cases the signification of the compound is figurative; as, umbringen, to bring about (*one's death*), *i.e.*, to *kill*.

Their effect, *when inseparable*, is, in connection with the radicals, to form certain *transitive* compounds; which, for the most part, are used in a figurative or metaphorical sense.

We subjoin a list of the prefixes of this class, illustrating each by a couple of examples; the first being one in which the prefix is separable, the second one in which it is inseparable:—

Durch, through;	Durch'dringen, to press or force through. Durchdrin'gen, to *penetrate*.
Hinter, behind;	Hinter'gehen, to go behind. Hinterge'hen, to *deceive*.
Über, over;	Ü'berſetzen, to set or put over. Überſetz'en, to *translate*.
Um, around;	Um'gehen, to go around. Umgeh'en, to *evade*.
Wieder, again; back;	Wie'derholen, to fetch or bring back. Wiederho'len, to *repeat*.

VERBS COMPOUNDED WITH NOUNS AND ADJECTIVES.

A variety of compounds is produced by the union of verbs with nouns and adjectives. These follow the same general laws which govern those produced by means of prefixes. Some of them, accordingly, are *separable*, as:—

Fehlſchlagen, to miscarry;	from	fehl	and	ſchlagen.
Freiſprechen, to acquit;	„	frei	„	ſprechen.
Gleichkommen, to equal;	„	gleich	„	kommen.
Losreißen, to tear away;	„	los	„	reißen.
Stattfinden, to take place;	„	ſtatt	„	finden.

Some are *inseparable*, as :—

Handhaben, to handle;	from	hand	and	haben.
Liebäugeln, to ogle;	„	lieb	„	äugeln.
Muthmaßen, to suspect;	„	muth	„	maßen.
Vollziehen, to perform;	„	voll	„	ziehen.
Willfahren, to gratify;	„	will	„	fahren.
Weiſſagen, to foretell;	„	weis	„	ſagen.

These verbs take the augment syllable ge- in the perfect participle; except vollziehen, which has vollzogen. In some cases, however, verbs compounded with voll also take the augment; as vollgegoſſen, from vollgießen, to pour full.

THE ADVERBS.

Adverbs in German, as in other languages, serve to modify the signification of verbs, participles, and often, also, that of one another; denoting for the most part certain limitations of time, place, degree, and manner. Hence they are usually classified according to their *meaning*.

They are indeclinable, and are formed, either by derivation or composition, from almost every other part of speech; of some, however, the origin is wholly unknown.

Arranged according to derivation, adverbs are divisible into the following classes :—

(1) ADVERBS FORMED FROM NOUNS.

Adverbs are formed from nouns by affixing the letter s. This termination s is nothing more than the sign of the genitive singular; which case, not only of nouns, but also of adjectives, participles, etc., is often made to perform the office of an adverb. Examples :—

Morgens, in the morning;	from	der Morgen, morning.
Tags, in the day;	„	der Tag, day.
Theils, in part, or partly;	„	der Theil, part.
Flugs, swiftly;	„	der Flug, flight.
Durchgehends, generally;	„	durchgehend, passing through.
Zuſehends, visibly;	„	zuſehend, looking at.

(2) ADVERBS FORMED FROM ADJECTIVES.

Adverbs are formed from adjectives by the addition of the suffixes -lich, -haft, and -lings; which, except the last, are also regular *adjective* terminations. These endings are chiefly expressive of manner, and may be translated sometimes by a corresponding suffix (as the English *-ly* or *-ishly*), and sometimes by some equivalent phrase. Examples :—

Wahrlich, truly, verily;	from	wahr, true.
Boshaft, maliciously;	„	böſe, evil, wicked.
Weislich, wisely;	„	weiſe, wise.
Freilich, sure, to be sure;	„	frei, free, sure.
Blindlings, blindly;	„	blind, blind.

The letter s, also, as above stated, added to adjectives, gives rise to a class of adverbs, thus :—

Rechts, on the right;	from	recht, right.
Links, on the left;	„	link, left.
Anders, otherwise;	„	ander, other.
Bereits, already;	„	bereit, ready.
Beſonders, particularly;	„	beſonder, particular.
Stets, continually;	„	ſtet, continual.

The letter s is also sometimes affixed to adverbs ending in mal; as, vormals, formerly; damals, at that time; vielmals, many times. For numeral adverbs ending in mal, lei, etc., see the section on Numerals.

Here note, also, that *almost all German adjectives in the absolute form—that is, in the simple form without the terminations of declension—are employed as adverbs:* thus, er rennt ſchnell, he runs rapidly; er handelt ehrlich, he acts honestly.

(3) ADVERBS FORMED FROM PRONOUNS.

These are, chiefly, da, *there* (from der, die, das, *this* or *that*); wo, *where* (from wer, was, *who, what*); her, *hither*, and hin, *thither* (from some corresponding demonstrative pronoun no longer found).

The pronominal adverbs, in combination with other words, give rise to a number of compounds. Thus da and wo, united with prepositions, serve often instead of the dative and accusative (*neuter*) of the pronouns der, wer, and welcher respectively. It will be noticed that when the other word begins with a vowel or with the letter n, da and wo are written dar and wor; that is, that r is inserted for the sake of euphony. The following are compounds of da and wo :—

Dabei, thereby, *i.e.*, by this *or* that.	Wobei, whereby, *i.e.*, by which.
Dafür, therefore, *i.e.*, for this *or* that.	Wofür, wherefore, *i.e.*, for which.
Damit, therewith, *i.e.*, with this *or* that.	Womit, wherewith, *i.e.*, with which.
Darin, therein, *i.e.*, in this *or* that.	Worin, wherein, *i.e.*, in which.
Darunter, thereunder *or* among, *i.e.*, under this *or* that.	Worunter, whereunder, among, *i.e.*, under which.
Darum, thereabout *or* therefore, *i.e.*, for this *or* that; therefore.	Worum, whereabout, *i.e.*, about *or* for which, wherefore; why.
Daran, thereon, *i.e.*, on this *or* that.	Woran, whereto, *i.e.*, to which.

Darauf, thereupon, *i.e.*, upon this *or* that.	Worauf, whereupon, *i.e.*, upon which.
Daraus, therefrom, *i.e.*, from this *or* that.	Woraus, wherefrom, *i.e.*, from which.
Davon, thereof, *i.e.*, of this *or* that.	Wovon, whereof, *i.e.*, of which.
Dazu, thereto, *i.e.*, to this *or* that.	Wozu, whereto, *i.e.*, to which.
Dadurch, there-through *or* thereby, *i.e.*, through *or* by this *or* that.	Wodurch, whereby, *i.e.*, by *or* through which

In like manner her and hin appear, also combined with other words. Between these two particles a distinction exists, wherever they are used, whether alone or in composition with other words, which should be well understood and always remembered. They are, in signification, exact *opposites:* her indicating motion or direction *towards* the speaker; hin implying motion or direction *away from* the speaker. The following are examples :—

Herab, down hither, *i.e.*, where the speaker is.	Hinab, down thither, *i.e.*, away from the speaker,
Herauf, up hither.	Hinauf, up thither.
Heraus, out hither.	Hinaus, out thither.
Herein, in hither; into this place.	Hinein, into that place.
Hierher, or hieher, hither here; this way.	Hierhin, thither; this way forward.
Herüber, over hither.	Hinüber, over thither.
Herunter, under hither.	Hinunter, under there.
Daher, from there hither, *i.e.*, thence.	Dahin, from thither (to) there, *i.e.*, thither.
Woher, from which place hither, *i.e.*, whence.	Wohin, from which place thither, *i.e.*, whither.

We have no words in English corresponding exactly in use and force with her and hin; and therefore, though everywhere in German their force may be *felt*, it cannot always be expressed by single words, in translation. Hence they are often treated as expletives.

COMPARATIVE ANATOMY.—VII.

[Continued from p. 114.]

CRUSTACEA.

OF all the Crustacea the forms best known to us are the lobster, crab, and prawn (Fig. 21), with a general description of which we will commence our account of this group, and then we will point out some of the modifications of this type. These creatures are in common speech called shell-fish, but this name is a bad one; for they are not fish, nor can their investment be called a shell, the word shell being more properly applied to the external secretions of the Mollusca. There is, however, one point of similarity in these two kinds of shell—namely, that the earthy salt carbonate of lime forms the hard deposit in both cases. This salt, which is the same as chalk, limestone, and Iceland spar, is the one which seems to be the most easily employed by invertebrates to strengthen those tissues which it is necessary should, for the purposes of the animal, be rendered hard and inflexible. This chalky induration is no doubt taken into the system while dissolved, and circulates with other constituents of the nutritive fluids, and only assumes its hard, stony, and solid form when it has reached the integument of the crustacean, and is there laid up in its cells. When once laid down, however, it seems to be but little liable to be redissolved and carried away again, as the organic substances of the tissues are. Probably the lime is absorbed while in some form more soluble than the carbonate, and only becomes the less soluble carbonate by becoming combined with the carbonic anhydride (CO_2), which, as we have seen, is a continual waste product of the system. The reason for this supposition is derived from the fact that when the animal is growing within its stiff hard shell, instead of the earthy particles being partially dissolved and rearranged with the deposit of more of such particles in the interstices, the whole shell is cast off with the layer of skin which encloses it, and the whole has to be reproduced from below. The whole integument or outer coating of the crustacean is a constantly vital inner layer permeated by the blood. Over this is a layer of pigment which gives the colouring to the animal, and which often exudes colouring matter which penetrates the whole of the shell which lies above it; and lastly, there is the external epidermal layer in which the shell is deposited. This last, with its involved chalk substance, is often of great thickness, and the chalk is laid down in closely applied rods or columns, which lie perpendicularly to the exterior of the animal. This epidermis corresponds to our scarf-skin. In its physical character it partakes of the nature of this and of horn. Chemically it is different from either of these, as it burns quietly to a white ash, without either melting, or swelling up as horn does. Moreover, caustic potash (KHO) will not melt it, nor will nitric acid (HNO_3) colour it yellow, as our epidermis is dissolved or coloured yellow by these several substances. This outer epidermis of the higher Crustacea, which is so thick and hard in some parts, also passes as a thin film over other parts, clothing the whole body and even extending inwards into the alimentary canal. So that when the creature casts off its old coat to allow it to grow, the old slough presents the

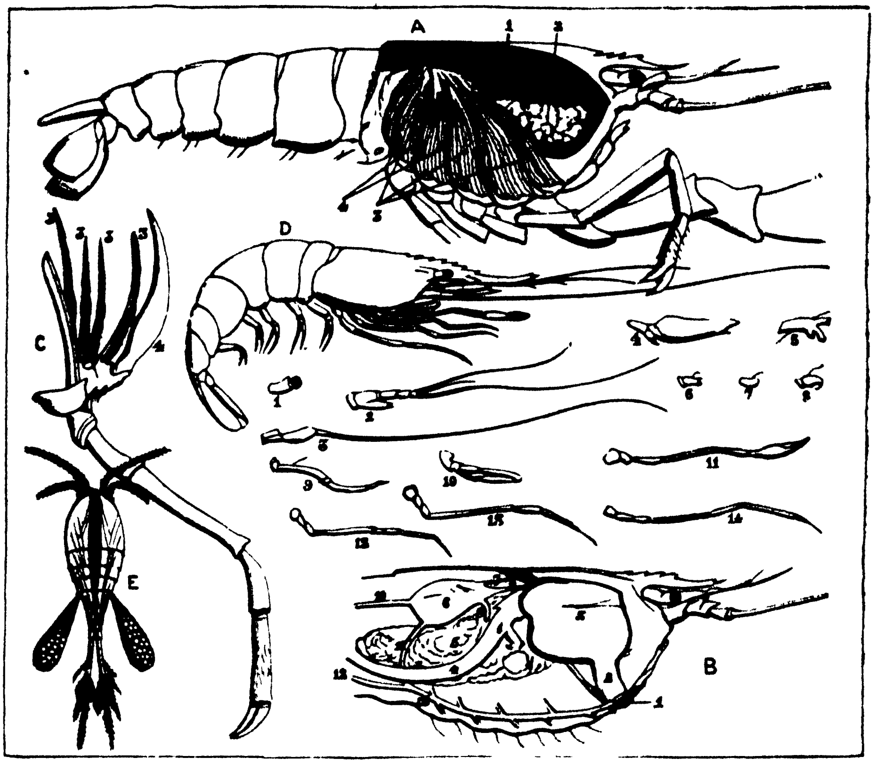

Fig. 27. A. Lobster with one side of the Carapace removed to show the Gill-chamber, Legs and Limbs as if cut short. B. Lobster represented as if cut through a little on the near side of the mid-line, only Cephalo-Thorax represented. C. Leg of Lobster, with Flap and Gills. D. Prawn (Crangon) and its separate parts detached. E. Cyclops with Egg-Pouches.

Refs. to Nos. in Figs.—A. 1, ovary; 2, liver; 3, gills; 4, flagellum. B. 1, jaw; 2, throat; 3, stomach; 4, intestine; 5, liver; 6, heart, with slits to receive venous blood; 7, artery to head; 8, artery to stomach; 9, artery to near lobe of liver; 10, artery to upper part of tail; 11, sternal artery dividing below into—12, sternal abdominal artery; 13, foot and gill artery. C. 3, 3, gills; 4, flap. D. 1, eyestalk; 2, 3, antennæ; 4—9, foot jaws; 10—14, walking limbs.

perfect shape of the living animal, and the coat of the stomach with its internal teeth are also found in connection with the rest. Thus truth is stranger than the wildest fiction. Baron Munchausen, when he could deal in no other way with an enraged wolf, thrust his hand down his throat, and turned him inside out like an old glove; but even Baron Munchausen would have been taken aback if after having done so he found the wolf none the worse. This exuviation, as it is called, is effected in the larger Crustacea by means of a transverse split which occurs between the great dorsal shield and the succeeding parts of the body. Through this the creature escapes, withdrawing all its limbs from their cases, and when they are so large and thick at their terminal joints (as the pincers of the crab are) as to prevent their extrication through the proximal joint-casings, these last split up, and so complete denudation is effected. The fresh skin formed below is at first quite soft and flexible, and the fierce truculent crab, with its formidable toothed and strong pincers, becomes for the time a poor defenceless coward, compelled to skulk about among the stones and chinks of the rocks to avoid enemies which a few days before and a few days after it would defy. There is a vast number of species of Crustacea, and the variations in the number of segments, and the number, position, and shape of the limbs, are almost endless. Another species, the common prawn, with the disarticulated appendages of the first fourteen segments of the body, or those which are included under the great shield of the back and called in the aggregate cephalo-thorax, is given in the illustration. In comparing the segmentation of Crustacea with insects, it is thought that the cephalo-thorax, with its stalked eyes, two pairs of antennæ, foot-jaws, and walking legs, corresponds not only to the head and thorax, but also with the fore part of the abdomen of insects. In accordance with this supposition, the part which succeeds to this, and which in the prawn is a large muscular tail, is called the *post*-abdomen; this post-abdomen has limbs, which is not the case with insects or spiders. The position of the principal internal organs would bear out the conclusion that the part corresponding to the front part of the abdomen of insects lies under this great shield. Under it lie the whole of the stomach, generative organs, large digestive organs, and heart, the main portions of which all lie in the limbless after-part of the insect. The mouth opens on the lower surface of the animal, and it is so covered with the great number of pairs of jaws, with their flaps and fringes which guard it, that it is difficult to disclose it. The throat leads upwards into a capacious oval or cubical stomach, whose walls are stiff and strong. It is lined internally with a pile of stiff hairs directed backward, and has at its hind part, from which the intestine proceeds straight to the tail, three strong teeth which masticate the food. This tooth apparatus is worked by muscles which run from the outer wall of the stomach to the shelly sides of the body. These muscles are under the control of the animal, and are worked at will.

The circulatory system has a definite, compact heart, in the form of an oval bag which sends vessels forward to the eye, head, antennæ, and stomach, sideways to the two large lobes of the liver, and downwards through a great trunk which divides into two: one running to the gills and legs, and the other backward to the tail. The blood from the gills finds its way into spaces lying immediately under the shell, which all communicate with one another, and the largest communicates with the heart by slits in the side of that organ. This arrangement of the blood system is rendered necessary by the breathing organs being confined to certain definite parts—the gills. In those Crustacea where there are no gills, the circulatory system is not so perfect. The gills are organs which sprout from above the basal joints of the walking legs. In the lobster there are as many as three or four to each leg. They consist of a tapering triangular stem upon which a vast number of little tubular projections are set. These are of thin membrane, and are supplied internally with blood from an artery which mounts the stem, diminishing as it ascends, while the aërated blood is discharged into a vein, which also lies in the stem and enlarges as it descends. Although these organs are essentially gills or outward extensions of the integument, yet they are too delicate to be exposed to the casualties of the outer world. They are therefore included under the dorsal shield. In the lower orders, however, they are exposed and attached to the members of other segments of the body. The gills are thus included in a chamber under the shield. It is of course essential that a free stream of water should pass over them, and to effect this there are two orifices which form the entrance and exit of the water. The entrance is a long slit behind and below the chamber; while the exit lies forward on the side of the mouth, and has covering it a large flap from the second pair of maxillæ or foot-jaws, which is continually worked so as to drive the water outwards. Aëration is maintained not only thus but by mechanical means within the chamber; for at the top of each leg there is, besides the gills, a long, stiff, leaf-like projection, which passes up between the gills, and as the animal walks this stiff flagellum squeezes the gills, and so renews both the water without and the blood within them. The position of these gills and flagellum will be seen in the illustration.

The nervous system is not unlike that of the earthworm, but the degree in which the chain of double nerve-knots is dissevered and gathered together varies vastly. Sixty pairs of ganglia are found in one species, and in the crab all except the brain, which is situated above the mouth and supplies nerves to the organs of sense, are gathered into one nervous mass. The eyes of the higher Crustacea are on the same plan as those of insects. They are, however, set upon jointed movable stems. A discussion of the claims which certain organs in the antennæ of the lobster have to be considered the nose and ear will be found in the lessons concerning those organs of sense. The enormously long antennæ of some of these creatures, which are well supplied with nerves, must be efficient organs of sense in the dense dark waters of the ocean.

The preceding remarks only apply to those higher families of the Crustacea included under the class Decapoda. We will now very briefly notice the remaining orders, which contain animals of somewhat different structure.

Amphipoda.—The eyes of these are not stalked, but their surface is on the same level as the rest of the body. The first joint of the thorax is made fast to the head, but the two following as well as all the abdominal segments are free. Only four pairs of limbs are transformed into foot-jaws. The gills are in the form of membranous plates, set on the middle thoracic segments. These are never covered in by the shell, but are freely exposed.

The example of this order which the reader will most likely have fallen in with is the sand-hopper, which is found in countless multitudes at the edge of the sea. The liveliness of these animals is remarkable, as they are constantly turning somersaults backwards, and in so doing jerk themselves violently into the air.

Isopoda.—These are segmented like the foregoing, and their gills are like them, but they are set, not on the middle, but the tail segments of the body. The woodlice (*Oniscus*), which, when touched, roll themselves into a perfect ball, are good examples of this order.

Branchiopoda.—These Crustacea have one to three pairs of jaws. Their thorax is undeveloped, and with a variable number of abdominal segments to which gill-feet are attached. Frequently the body of these is covered by a shell. The *Cypris*, which is found in almost every pool of water, belongs to this order. The shells of these are often beautifully marked, and as they are found preserved in geological strata, they have been very useful in determining the nature of those strata. Thus, wherever a cypris is found, it is considered certain that the earth was deposited from fresh water; and the nature of their markings is so distinct that the different species are easily distinguished by the shell alone.

Entomostraca.—These have a well-developed cephalo-thorax. Their abdominal feet are split into two portions, and they are without distinct organs of respiration. To this order belongs the *Cyclops*—thus named on account of its centrally situated single eye. Many also of those shapeless parasites which cling to the gills, eyes, and mouths of fishes, are classed with the Entomostraca.

Cirripedia.—In these, the two sexes are combined in one individual. They are fixed animals, and have a mantle which is furnished with plates of carbonate of lime, like the bivalve shells of molluscs. These are the barnacles. They were long thought to be molluscs, but have all the essential features of true Crustacea.

We have found it convenient to descend in the scale while describing these orders; but it must not be forgotten that the order should be reversed in a tabular classification. Thus :—

1. *Phyllopoda* (*φύλλον, leaf; ποὺς, foot*), leaf-footed Crustacea.
2. *Ostracoda* (*ὄστρακον, shell*), shelled Crustacea.
3. *Copepoda* (*κώπη, oar*), with oar-like feet.
4. *Cirripedia* (cirrus, *a tendril;* podes, *feet*), animals with tendril-like feet.
5. *Isopoda* (*ἴσος, like; ποὺς, foot*), with like (thoracic) feet.
6. *Amphipoda* (*ἀμφί, both; ποὺς, foot*), animals with both kinds of feet on the thorax, *i.e.*, with walking feet and gill feet.
7. *Decapoda* (*δέκα, ten; ποὺς, foot*), animals with ten walking legs.

Another order called Trilobites inhabited our globe at that very remote period when the primary strata were deposited; not one of them have survived that period. Their remains are, however, found in great multitudes, and the number of species was large. From these remains we learn that they had a head and tail shield with free segments in between. Their eyes were compound. They could roll themselves into a ball like woodlice. It would seem that they are more nearly allied to the Arachnida, and that their nearest living form is the king-crab (*Limulus*).

ARACHNIDA.

The type of this class, and that which gives it its name, is the common spider. According to Greek mythology, Arachne was the daughter of a famous Lydian purple-dyer. She so excelled in weaving that she challenged the great Athena, goddess of all the arts, to compete with her. To display her skill, she wove a piece of tapestry representing the loves of the gods, which was so faultless that Athena herself could not find a flaw in the design or execution. Not to be baffled, the goddess did what so many mortals do when surpassed by others—she tore the masterpiece to fragments. Arachne, in despair, essayed to hang herself; but Athena, more in anger than in kindness, changed the rope into a cobweb, and Arachne into a spider. If this legend should induce anyone to be a little more considerate, or a little less needlessly destructive of these creatures, which are neither ugly nor uninteresting, it is worth repeating. The unfortunate Arachne still weaves her inimitable fabrics, and still hangs suspended from our ceilings, while the omnipotent housemaid, goddess of this lower sphere, still rends her web, and drives the weaver to despair. The little metamorphosed Lydian dyer's daughter excites a childish disgust, which is handed down from generation to generation; but if anyone will substitute a reasonable examination for an unreasonable avoidance, he will find that beautiful which he preconceived was ugly, and that interesting which he misjudged as repulsive. In those dark ages when superior wisdom and virtue were more certain to bring to their possessors hopeless imprisonment than the greatest crimes, many a solitary prisoner of refined and appreciative nature has waited to see the little Arachne descend from the roof of his cell with as much impatience as any lover beneath the casement of his love. Since the spinning faculty is that which is most intimately connected with our idea of a spider, it was extremely natural that the old Greeks should make the spider represent a woman. Despite its false fame of ugliness, we, who call single ladies spinsters, naturally associate the spinder, or spider, with them. Unfortunately for the reputation both of spiders and women, we cannot stop short in admiration of the art displayed in the construction of the web, but the mind runs on to the design and uses for which the art is employed. These designs are to ensnare and to destroy. Hence deceit and cruelty, the vices of the weak, have been attributed to spiders. The bitterest satirists of the fair sex have found in the spider a simile which has pointed their invective from the earliest ages of literature. Thus, in one of the most famous tragedies of Æschylus, when the chorus find Agamemnon slain in his bath by his deceitful wife Clytæmnestra, they exclaim—

"*Κεῖσαι δ'ἀράχνης ἐν ὕφασματι τῷδ'*
ἀσεβεῖ θάνατῳ βίον ἐκπνεων."
"Thou in the female spider's toils art lying,
And breathest forth thy life, dishonoured dying."

Since the spider is our type of the class, we shall first call attention to the characters which it possesses in common with the whole class Arachnida; then proceed to describe the structure of the common spider in detail; and finally notice the variations of this type in the different divisions of this class, such as scorpions, mites, etc.

The Arachnida are articulated animals whose bodies consist of a longitudinal series of segments like those of insects. This segmentation into rings is, however, often less marked than in insects; and in the true spiders, which have a smooth soft integument, the divisions are rather inferred, from tracing them in allied forms or in the embryonic state, as they become more and more obliterated, than from any indication of their actual presence in the adult animal. In all cases they are distinguished from insects by having no marked division between the head and thorax. Both these divisions are combined, as in the higher crustaceans, into one piece, called the cephalo-thorax. In the mites a still further amalgamation of the divisions of the body into one globate bag occurs, which represents at once head, thorax, and abdomen. Where there is a constriction between the thorax and abdomen, so that one can be distinguished from the other, the limbs are wholly confined to the thorax. This distinctive feature cuts them off from the Myriopoda and Crustacea. The Arachnida never possess wings, and instead of the three pairs of legs of insects, they have four pairs. These limbs are all jointed, but they are built upon a somewhat different type to those of insects, as we shall find when we come to describe them more minutely.

The jaws, situated farther back, are characterised by the enormous development of the palps. These palps are so elongated and jointed in the spiders that they would be taken for legs by an ordinary observer, and hence spiders appear to have ten instead of eight legs. In scorpions these maxillary palps are larger than any of the other limbs, and will be described hereafter. The eyes of the Arachnida are, when they are present, always simple and few in number—eight, six, four, or two being commonly found. They never have a multitude of hexagonal or quadrate ocelli grouped into one organ as insects have. The method of breathing is very various in the class, the lowest having their tissues oxygenated through the skin, others having tracheæ like insects, while others have what are called lungs. The sexes are usually distinct, the females exceeding the males in size With the exception of the Pantopoda (or Pycnogonida), none of the Arachnida are marine in their habitat. Some of the lower orders inhabit fresh water, as, for instance, the little scarlet water-spider. The major part live in and breathe air.

We will now take a common spider as the example of the class, so that we may go into detail without misleading the reader by the idea that the description will apply to other members of the class.

The cephalo-thorax is somewhat flattened; its integument is of a harder consistence than that of the abdomen. The upper plate is called the shield, and the lower the breastplate or sternum. Between the edges of these two, along the sides of the body, spring the legs. The shield is wider than the breastplate, and overlaps it, so that while the bases of the legs are well seen from below they are not seen from above. The shield is usually narrower in front, and wider and heart-shaped, or rounded, behind. It is raised into a conical protuberance at the fore part, and on this the eyes are set. The breastplate is often rounded, or heart-shaped, with the apex backward, or in the form of an escutcheon. The box of the cephalo-thorax contains the stomach, main nervous masses, and the muscles of the limbs. The eyes in the common spider are eight in number, in two transverse lines of four each. Their relative position, number (two, six, or eight), and size are much depended

on to distinguish the genera. Sometimes they are mounted on a pyramid, or elevated watch-tower, which rises from the shield in a very grotesque manner.

A PLAY IN THE DAYS OF SHAKESPEARE.

ENGLISH LITERATURE.—IX.

[*Continued from p.* 139.]

THE ELIZABETHAN PERIOD—THE DRAMA.

THE great glory of the Elizabethan period is its drama. But in order to realise the development of the drama during this age it is necessary to know something of what it had been before.

The earliest plays in England, as throughout Europe generally, were essentially religious in character, and intended to convey religious truths in the most striking manner to an illiterate people. They were for the most part written by churchmen, and acted by the clergy in the larger churches. Some of these plays, which were no doubt acted upon some of the great festivals of the Church, represented in a dramatic form the principal events of the Bible history, and were intended to illustrate and impress upon the popular mind the leading doctrines of the Christian faith. These plays were, not unnaturally, called "mysteries." Others were founded upon the legends of the saints, and represented the wonders of their lives and deaths. These were probably acted upon the festivals of the saints whose deeds and sufferings they depicted, and were with appropriateness called "miracles" or "miracle plays." Such were the dramatic entertainments of Christian Europe during the middle ages; and the "Passion Play," which is still acted every tenth year at Ober-Ammergau in the Tyrol, and which draws the Tyrolese peasants together in thousands to gaze in devout wonder at a dramatic representation of the life and death of Christ, is exactly the "mystery" of the middle ages, which has survived in that remote corner of Europe centuries after it has been forgotten elsewhere.

It is probable that such plays were introduced into England from France soon after the Norman Conquest. The earliest of them were in Latin; perhaps then for a time in England in French. But in this, as in other departments, the English tongue overcame its competitors, and became the established language of the religious drama.

In course of time a variety was introduced into these religious plays. In the mysteries and miracles, as we have seen, the characters were real personages, and the incidents were historical or what were supposed to be historical facts. The "morals" or "moralities," which came into vogue at a later date, were allegorical, not historical. Instead of the virtuous and vicious personages of sacred history, they had as their characters the various virtues and vices themselves, and other abstract conceptions, brought upon the stage, together with personifications of mankind in general, or other representatives of ordinary humanity, which are shown as acted upon by the various passions or principles represented by the allegorical personages. One of the most important characters in all these plays was the vice, probably the lineal ancestor of the modern clown. He was a kind of buffoon, and to him, together with the devil—who had performed the same function in the older mysteries, and who was still retained in the moralities—was entrusted most of the comic element in such pieces.

We have already said that in the earliest times the mysteries and miracle plays were not only religious in subject, but religious in purpose too, being acted by clerical persons in sacred places with a view to instruction, and on the occasion of religious solemnities. Thus, of the most important sets of mysteries which have come down to us, one set was acted annually on Corpus Christi Day by the Grey Friars at Coventry. Another set was acted, it is supposed, at the abbey of Widkirk. But in course of time, though the subjects of the plays remained the same, the whole spirit of the performance became changed. What had once been a religious ceremonial became a mere popular entertainment. One marked step in this process was made when these plays came to be acted by others than the clergy, or those connected with the clergy, and in other than sacred places. Thus a third important set of old mysteries which have come down to our times were acted yearly in Whitsun week by the trade guilds of Chester, each of the twenty-five separate plays of which the set consists being assigned to a particular trade, by the members of which it was acted from year to year. These plays, too, were not performed in any sacred place, but upon movable stages at various points in the streets of Chester; the plan being that, as each play was finished in one street, stage and all was moved away to another street, making room for the play next in order, so that all the plays were going on at once, and each in its turn made the circuit of the town. Nor was it only in the case of such great popular exhibitions as these that the performance of the mysteries was losing its religious character. They came to be acted at Court festivities and on other similar occasions purely secular. The moralities, too, in which abstract virtues and vices took the place of the most sacred real characters, evidently appealed far less to religious associations than the older form of play had done, and so tended to secularise the stage.

Up to a very early period the existence of mysteries and miracle plays in England may be traced, and before very long the distinction between the two terms came to be neglected, and they were used almost indiscriminately. In a later period, allusions to such plays are common in Piers Ploughman and in Chaucer's works. Not long afterwards, early in the fifteenth century, the moralities began to come into vogue. They never entirely superseded the earlier form of play, but they gradually gained upon them until they very nearly supplanted them. Both, however, continued to be acted down to the time of Elizabeth. There is clear evidence that mysteries and morals were both acted, though probably less and less frequently, during the whole of her reign and down to its very close, if not even to a somewhat later period. They only faded away before the splendour of the Elizabethan drama.

The prevalence of the morality over the more sacred mystery was evidently a step towards bringing the drama to deal with the subjects of real life and real human character. A further advance in this direction was made by the class of short plays, or rather scenes, which have received specially the name of "interludes." They were short comic pieces, each of a single scene, generally of a broadly humorous character—intended, perhaps, to be acted in the intervals of longer performances. The principal writer of these pieces was John Heywood, who held the office of Court jester under Henry VIII.

The transition state of the drama before the accession of Elizabeth and in the early days of her reign is well illustrated by the career and works of Bale. John Bale was a churchman, and a man of extensive and varied learning, a laborious author, and an eager controversialist. Early in life he embraced the reformed faith, and under Edward VI. he was made Bishop of Ossory. The accession of Queen Mary obliged him to leave his Irish see; and, although restored under Elizabeth, he never returned to it, but died in England five or six years after that queen's accession. He was the author of several prose works, of which the most important is a Latin biography of British authors. But it is as a dramatist that we are concerned with him at present. He was one of the most diligent writers of religious plays in the old forms, mysteries and moralities. But in his hands, as in many others, apparently, at that time, they are no longer designed for the simple teaching of the undisputed truths of Christianity—his plays, whatever their form, are in substance controversial attacks upon Popery, in bitter contest with which his whole life was spent. But in addition to his plays of this class, he was the author of one which forms an important connecting link between the old and the new drama. His play of *King John* is founded upon the old chronicles of that king's reign, which it follows pretty closely; but the play partakes also of the characteristics of the morality, for side by side with the historical personages with whom we are familiar we find the stage occupied by such abstractions as Widowed England, Verity, Treason, and Sedition. This is the oldest historical play extant, but it was soon followed by others of the same class.

The first regular comedies in the language belong to about the same period. The earliest comedy which has come down to us is *Ralph Royster Doyster*, written by Nicholas Udall, master first of Eton and afterwards of Westminster School, which was acted in the year 1551. This is a comedy of considerable force and spirit, representing the vices, follies, and misfortunes of a rich and senseless young man, Ralph Royster Doyster, surrounded by a troop of flatterers, who live upon him and lead him into every sort of trouble. Of somewhat later date, but of far inferior merit, is the comedy of *Gammer Gurton's Needle*, supposed to have been written by John Still, Bishop of Bath and Wells. The play is founded upon a farcical incident of low life, but the humour of the piece never rises above the merest and coarsest buffoonery.

Very little later we meet with the first regular tragedies. Among these, one of the earliest, if not the very earliest, is the tragedy of *Gorboduc, or Ferrex and Porrex*. This play was the joint production of Thomas Sackville, Lord Buckhurst (a poet of whom we have already given some account, when speaking of the "Mirror for Magistrates," the great work designed and in part executed by him), and of Thomas Norton; and it was acted in 1562. It is founded upon a story from the legendary British history—a story which had been several times used for poetical purposes before, amongst other places in the "Mirror for Magistrates" itself. The story is a very tragic one, by no means ill suited for representation on the stage; and the language of the play is dignified and not wanting in eloquence. But the play, as a play, is lifeless and uninteresting. It is written in blank verse; the earliest example of the use of this metre in dramatic composition. This tragedy was rapidly followed by others of the same class; and thus by a very early period in the reign of Elizabeth the three main kinds of drama which were cultivated with most success in the Elizabethan age—tragedy, comedy, and history—were already in existence, though the art of dramatic composition was merely in its infancy.

But before we go on to notice the Elizabethan dramatists properly so called, it will probably assist the student if we describe shortly the external materials with which the dramatist of that day had to work. It will be gathered from what we have already said that in the earliest times there were no buildings specially set apart for the performance of plays, and no class of men whose business was to act them. The earlier mysteries were acted in church and by the clergy; the Chester plays in the streets of Chester, and by members of the trading guilds of the city. The banqueting halls of palaces and baronial castles, the dining halls of the inns of court—these, and probably many similar and far less suitable buildings, served as theatres; and the members of the household, or of the inn of court, or any similar body of persons, did duty as actors. Thus the tragedy of *Gorboduc* itself was acted before the Queen at the Palace of Whitehall, by the members of the Inner Temple. But, while the practice of public and periodical dramatic representations, by amateurs of such classes and in such places as we have described, long continued common, a great step in the history of the drama was made in the institution of regular theatres and professional actors. The latter innovation long preceded the former, for professional actors were to be found some time before the close of the fifteenth century; but they were at first, and for a long time continued to be, at least nominally, in the service of some peer or great man, and are always described as the Earl of Leicester's servants, etc., as the case may be, Indeed, actors not under such protection were apt to be roughly treated as rogues and vagabonds. The early actors seem, however, to have been companies of strolling players such as that which, in *Hamlet*, visits the Danish Court at Elsinore. But early in the reign of Elizabeth regular theatres, specially built and reserved for the acting of plays, began to be established, and rapidly increased in number in proportion to the development of the drama.

One result of the increase in numbers, and the concentration and general improvement in the status of the dramatic profession during Elizabeth's reign, is too remarkable to remain unnoticed. Actors became authors. Each company of players endeavoured to produce for themselves the pieces they needed for representation, which remaining unpublished, became a valuable part of the property of the company, and a special attraction to the theatre. Thus Marlowe, Ben Jonson, Shakespeare himself, and many more of the Elizabethan dramatists, were all actors both before and after they became famous as authors.

In order to appreciate the Elizabethan drama, it must further be remembered that the theatre and all its accessories were then very unlike what they are now. The theatre itself was generally a rough wooden building with a rude thatched roof, sometimes open in the centre; the spectators, sitting or standing, for the most part arranged somewhat as they are at present, but in part on the stage itself. The elaborate scenery of modern times was unknown to Shakespeare's contemporaries. The stage in those days was a simple stage and no more, with perhaps a gallery or scaffold above it to do duty for a castled wall or any other elevated place from which a character had to speak. The presence on the stage of a chair of state, a bed, or a table, was enough to indicate that the scene was in a royal presence-chamber, a bed-room, or an inn. Another difference between the early and the modern stage is that in the Elizabethan age there were no women actors. The female parts were then all acted by boys, for women never appeared on the stage till after the Restoration. This is a subject frequently alluded to in the plays of the Elizabethan period, as for instance in Hamlet's address to the boy actor, "What, my young lady and mistress! By-'r-lady, your ladyship is nearer heaven than when I saw you last by the altitude of a chopine. Pray God, your voice, like a piece of uncurrent gold, be not cracked within the ring." All these circumstances compelled the dramatists of those days to rely on their own genius and their power of arousing the imagination of their hearers for the effect they sought to produce, instead of upon the skill of the scene-painter, the mechanician, or any other external appliance; and this, probably, in an age of such superabundant power, proved favourable to dramatic genius.

The greatness of the Elizabethan drama, as of other branches of literature in the same era, belongs to the latter half of the queen's reign, and still more strikingly to that of her successor.

John Lyly, whose "Euphues" and the fashion of Euphuism to which it gave a name we have already mentioned, was also a dramatist of considerable reputation. His plays are founded upon mythological stories, one of the best known being upon the story of Endymion. These plays have much of the character of the masque, of which we shall have to speak hereafter; and they seem to have been designed in the first instance for representation at Court rather than on the public stage, though they afterwards made their way to the regular theatre.

Thomas Kyd, also one of the earlier of the Elizabethan dramatists, is known to fame chiefly as the author of two very remarkable plays, *Jeronimo*, and its continuation, *The Spanish Tragedy*. These plays are tragedies of the gloomiest cast, but they show very great dramatic power in dealing with a purely tragic subject, and they attained a wonderful popularity. There is much doubt, however, whether the finest passages in the latter play, those which Lamb describes as the very salt of the play, are the work of Kyd, or of Ben Jonson, to whom they have been commonly ascribed, or of some other dramatist.

George Peele, to whom a very high place among the Elizabethan dramatists has been assigned by some critics, is chiefly distinguished by the ease and melody of his versification. This is strongly shown in his most celebrated play, *David and Bethsabe;* but the power which this play shows is more descriptive than dramatic.

Robert Greene was a vigorous and prolific writer of pamphlets and short miscellaneous prose pieces of various kinds. He was also a popular dramatist, his plays being chiefly comic.

Thomas Lodge was equally known as a physician and a dramatist. His best known play is *The Wounds of Civil War, lively set forth in the true tragedies of Marius and Sylla.*

But of the dramatists before Shakespeare, incomparably the greatest was Marlowe. Christopher Marlowe was the son of a shoemaker at Canterbury, and was born in that town in 1564. He received his early education at a free school in Canterbury, and was afterwards, probably by the bounty of some relative or other patron, sent to the University of Cambridge. He had thus, like most if not all of the Elizabethan dramatists, the benefit of a liberal education. After taking his degree, he followed the example of many young men of similar class and education in that day, and became an actor. The remainder of his short life was spent in the wildest debauchery; and he died in 1593 at the age of thirty, it is said from a wound received in a drunken tavern quarrel. In a life so short, and spent as his was spent, Marlowe's works could scarcely have been very numerous, and they are of very unequal merit. Some of his plays, as that of *Tamburlaine*, though never without passages of great poetic beauty, are deformed by the grossest extravagance of conception, expressed in the most inflated and bombastic language. So much is this the case that some scenes might well pass for burlesque, rather than serious dramatic writing; as, for instance, the famous scene in *Tamburlaine*, in which the Tartar chief appears in a chariot drawn by captive kings with bits in their mouths, reins in his left hand, and in his right a whip, and thus addresses the kings:—

> "Holla, ye pampered jades of Asia;
> What! can ye draw but twenty miles a day?"

Whether these faults are to be attributed to the extravagance of youth, or to a deliberate intention on the part of a man who had his bread to make to write down to the level of his audience, and gratify the lower tastes of the groundlings, it is at least clear that the dramatic genius of Marlowe is not to be measured by such plays as *Tamburlaine*.

The three plays by which Marlowe is to be judged, not only as to what his powers were, but what they might have been had he lived to the full maturity of his genius, are *The Jew of Malta*, *Doctor Faustus*, and *Edward II*. Barabbas, the Jew, in the first of these plays, is a monster of avarice and cruelty, painted with great power; but in obedience, no doubt, to the popular notion of Jews in his day, Marlowe has, after all, painted a monster rather than a man. It has often been suggested that Shakespeare's Shylock was in some degree taken from Marlowe's Barabbas; but, though the idea of introducing such a character may well have been borrowed by Shakespeare from his predecessor, the characters themselves have little in common, and are radically unlike *Edward II.* is a play of far higher merit. It contains passages showing a power of pathos rarely equalled. But the greatest of Marlowe's plays is *Faustus*. It is founded upon the same story as the "Faust" of Goethe; but the treatment of the story by the two poets is as different as might have been expected in the case of the actor of the sixteenth century and the philosopher of the close of the eighteenth.

In Marlowe's hands, the story is simply that of a great scholar and man of science who, devoting himself to the forbidden arts of magic, sells his soul to the devil, in return for four-and-twenty years of enjoyment of all earthly and sensual pleasures; and the interest of his play arises out of the tragic scenes for which the story gives occasion. The closing scene of Faustus' life well illustrates Marlowe's powers.

The end of the twenty-four years is very near, and Faustus is left alone by his scholars to meet his fate:—

[*The clock strikes eleven.*]

Faustus.—Ah, Faustus,
Now hast thou but one bare hour to live,
And then thou must be damned perpetually!
Stand still, you ever-moving spheres of heaven,
That time may cease, and midnight never come!
Fair Nature's eye, rise, rise again, and make
Perpetual day; or let this hour be but
A year, a month, a week, a natural day,
That Faustus may repent and save his soul!
O lente, lente currite, noctis equi!
The stars move still, time runs, the clock will strike,
The devil will come, and Faustus must be damned.
Oh, I'll leap up to my God! Who pulls me down?
See, see, where Christ's blood streams in the firmament!
One drop would save my soul; half a drop. Ah, my Christ!—
Ah! rend not my heart for naming of my Christ!
Yet will I call on him. Oh, spare me, Lucifer!—
Where is it now? 'Tis gone; and see where God
Stretcheth out His arm, and bends His awful brows!
Mountains and hills come, come and fall on me,
And hide me from the heavy wrath of God!
No, no!
Then will I headlong run into the earth:
Earth gape! Oh, no, it will not harbour me!
You stars that reigned at my nativity,
Whose influence hath allotted death and hell,
Now draw up Faustus, like a foggy mist,
Into the entrails of yon labouring cloud,
That when you vomit forth into the air,
My limbs may issue from your smoky mouth,
So that my soul may but ascend to heaven!

[*The clock strikes the half-hour.*]

Ah, half the hour is past! 'Twill all be past anon.
O God, if Thou wilt not have mercy on my soul—
Yet for Christ's sake, Whose blood has ransomed me,
Impose some end to my incessant pain;
Let Faustus live in hell a thousand years,
A hundred thousand, and at last be saved!
Oh, no end is limited to damned souls!
Why wert thou not a creature wanting soul;
Or why is this immortal that thou hast?
Ah, Pythagoras' metempsychosis! were that true,
This soul should fly from me, and I be changed
Into some brutish beast! All beasts are happy,
For, when they die,
Their souls are soon dissolved in elements;
But mine must live still, to be plagued in hell.
Curs'd be the parents that engendered thee!
No, Faustus, curse thyself, curse Lucifer,
That hath deprived thee of the joys of heaven.

[*The clock strikes twelve.*]

Oh, it strikes, it strikes! Now, body, turn to air,
Or Lucifer will bear thee quick to hell!

[*Thunder and lightning.*]

Oh, soul, be changed into little water drops,
And fall into the ocean; ne'er be found. [*Enter devils.*]
My God, my God, look not so fierce on me!
Adders and serpents, let me breathe awhile
Ugly hell, gape not! come not, Lucifer!
I'll turn my books ah! Mephistophelis!

[*Exeunt devils with Faustus.*]

COMMERCIAL CORRESPONDENCE.—IV.

[*Continued from p.* 141.]

FRENCH, GERMAN, AND ENGLISH.

21—LETTER OF INTRODUCTION,

Stuttgart, January 4th, 1891.

Gentlemen (Sir),—We beg to introduce to you the bearer, Mr. ——, whom we recommend to your kindness.

We at the same time open in your account a credit of £1,000, to which amount please furnish Mr. —— with the sums he requires upon his receipts, which please send us, when debiting our account for your payments.

Accept beforehand our best thanks for the services you will render Mr. ——, and believe us to be,

Gentlemen (Sir),

Faithfully yours,

J. Weber & Co.

Mr. ——, London,

Valid for —— months.

Stuttgard, le 4 *janvier*, 1891.

Messieurs (Monsieur),—Nous prenons la liberté d'introduire chez vous par ces lignes, et de vous recommander à un accueil obligeant, M. ——.

Nous l'accréditons chez vous pour la somme de £1,000 (nous disons mille livres sterling). Veuillez bien payer jusqu'à cette concurrence l'argent dont M. —— aura besoin, et nous en débiter sous envoi de ses quittances.

Nous vous remercions d'avance de ce que vous voudrez faire en faveur de M. ——, et de vous prions d'agréer l'assurance de notre parfaite considération,

J. Weber & Cie.

M. ——, à Londres.

Valable pour —— mois.

Stuttgart, 4 Januar, 1891.

Herr . . .

Wir erlauben uns Ihnen im Überbringer dieſer Zeilen Herrn N. N. vorzuſtellen, welchen wir Ihrer freundlichen Aufnahme empfehlen.

Gleichzeitig eröffnen wir dem Genannten bei Ihnen einen Credit von £1000, bis zu welchem Betrage Sie Herrn N. N. die von ihm gewünſchten Summen gegen Quittungen auszahlen wollen, und belieben Sie uns letztere, zuſammen mit der Belaſtungsaufgabe für Ihre Zahlungen, einzuſenden.

Genehmigen Sie im Voraus unſern verbindlichen Dank für die Dienſte welche Sie Herrn N. N. gütigſt leiſten werden.

Hochachtungsvoll,

J. Weber & Co.

Herr . . . ., London.

Gültig für . . . Monate.

22.—LETTER IN REPLY TO AN ORDER FOR AN ARTICLE WHICH HAS BEEN SOLD.

Bremen, March 18*th*, 1891.

Messrs. Smith Brothers, London.

Gentlemen,—I regret extremely to have to inform you that the article in question has been sold to Mr. Barton, of your city. Perchance you might come to an understanding with him.

I have some pretty articles of a different kind (a list of which I subjoin) that might possibly suit you.

I am, Gentlemen,

Faithfully yours,

J. Lemaitre.

Bremen, le 18 *mars*, 1891.

Messieurs Smith Frères, à Londres.

Messieurs,—Je regrette infiniment de vous dire que l'article demandé a été vendu à M. Barton, de votre ville. Peut-être pourriez-vous entendre avec lui à cet effet.

J'ai de jolis objets d'un autre genre (dont je vous envoie une liste) qui, probablement, pourraient vous convenir.

Agréez, Messieurs,

l'assurance de ma parfaite considération,

J. Lemaitre.

Bremen, 18 März, 1891.

Herren Gebrüder Smith, London.

Zu meinem lebhaften Bedauern muß ich Ihnen die Mittheilung machen, daß der betreffende Artikel an Herrn Barton dort, verkauft wurde. Vielleicht werden Sie ſich mit dem Genannten hierüber verſtändigen können.

Ich beſitze einige hübſche Artikel von einer anderen Sorte (wovon ich ein Verzeichniß beifüge) welche Ihnen möglicherweiſe dienen würden.

Hochachtungsvoll,

J. Lemaitre.

23.—LETTER OF INTRODUCTION, AND OF CREDIT.

Metz, January 15*th*, 1891.

Messrs. Armand Roubot & Co., London.

Gentlemen,—The bearer of this letter, Mons. F. Decretelle, of this city, is one of our oldest friends. He purposes visiting England, and we take the liberty of recommending him to your care.

Should M. Decretelle require some funds for travelling expenses, please to let him have all he wants to the extent of £500, taking his draft on us at three days' sight. Subjoined we send you his signature.

If you can in any way further the ends for which he has undertaken this journey, we should feel greatly obliged.

We are at your service on similar occasions,

And remain, Gentlemen,

Yours truly,

Henri de la Tour and Son.

Metz, le 15 *janvier*, 1891.

Messieurs Armand Roubot et Cie, à Londres.

Messieurs,—Le porteur de cette lettre, Mons. F. Decretelle, de cette ville, est un de nos anciens amis. Il se propose de faire un voyage en Angleterre, et nous prenons la liberté de vous le recommander.

En cas où M. Decretelle aurait besoin de quelque argent pour ses dépenses de voyage, ayez la bonté de lui compter ce qu'il vous demandera, jusqu'à concurrence de £500 (nous disons cinq cents livres sterling) contre sa traite sur nous à trois jours de vue. Ci-joint nous vous donnons sa signature.

S'il vous est possible de l'aider à atteindre le but de son voyage, nous vous en serions très-reconnaissants.

Toujours dévoués à vos ordres en pareille occasion,

Nous vous saluons cordialement,

Henri de la Tour et Fils.

Metz, 15 Januar, 1891.

Herren Armand Roubot & Co., London.

Der Überbringer dieſer Zeilen, Herr F. Decretelle, von hier, iſt einer unſerer älteſten Freunde. Er beabſichtigt England zu beſuchen, und erlauben wir uns, ihn Ihrer freundlichen Aufnahme zu empfehlen.

Falls Herr Decretelle Reiſegelder bedürfen ſollte, ſo wollen Sie ihm ſolche bis zur Summe von £500 auszahlen, gegen ſeine Tratte auf uns, drei Tage Sicht. Untenſtehend finden Sie ſeine Unterſchrift.

Wir würden Ihnen ſehr verbunden ſein, wenn Sie dem Genannten zur Erreichung des Zweckes ſeiner Reiſe behülflich ſein wollten, und ſtellen wir unſere Dienſte bei ähnlichen Gelegenheiten gern zu Ihrer Verfügung.

Hochachtungsvoll,

Henri de la Tour und Sohn.

25.—Letter acknowledging Receipt and advising Payment of Bills.

Lyons, October 7th, 1891.

Messrs. Reilton, Sons & Co., Bradford.

Dear Sirs,—We duly received your favour of the 3rd inst. covering

fr. 200	per 12th inst.	on St. Etienne.
„ 300	„ 15th „	
„ 1,200	„ 17th „	
„ 4,000	„ 19th „	
„ 375	„ 15th „	on Vienna.
„ 2,168	„ 14th „	on Grenoble.

with which we shall do the needful, placing the amounts to your credit under advice.

Please take note that the following bills have been duly paid.—

fr. 700	„ 25th ultimo	on Grenoble.
„ 300	„ 28th „	
„ 2,000	„ 31st „	
„ 5,000	„ 31st „	on St. Etienne.

which amounts we have placed to your credit.

Believe us, dear Sirs,

Yours truly,

M. Berthou & Co.

Lyon, le 7 octobre, 1891.

Messieurs Reilton Fils & C^{ie}, à Bradford.

Chers Messieurs,—Nous avons bien reçu votre honorée du 3, couvrant

fr. 200	au 12 ct.	sur St. Étienne.
„ 300	„ 15 „	
„ 1,200	„ 17 „	
„ 4,000	„ 19 „	
„ 375	„ 15 „	sur Vienne.
„ 2,168	„ 14 „	sur Grenoble.

dont nous soignerons le nécessaire à votre crédit sous avis.

Veuillez prendre note que les traites suivantes ont été dûment payées:

fr. 700	au 25 dernier	sur Grenoble.
„ 300	„ 28 „	
fr. 2,000	au 31 dernier	sur Grenoble.
„ 5,000	„ 31 „	sur St. Étienne.

dont nous avons passé les montants à votre crédit.

Agréez, chers Messieurs,

nos salutations distinguées,

M. Berthou & C^{ie}.

Lyon, 7 October, 1891.

Herren Reilton Söhne & Co., Bradford.

Wir empfingen Ihr Geehrtes vom 3 curr. mit folgenden Rimeſſen:

fs. 200	per 12 curr.	auf St. Etienne.
„ 300	„ 15 „	
„ 1,200	„ 17 „	
„ 4,000	„ 19 „	
„ 375	„ 15 „	„ Wien.
„ 2,168	„ 14 „	„ Grenoble.

womit wir das Nöthige beſorgen werden, und werden wir Sie ſ.z. unter Aufgabe dafür erkennen.

Notiren Sie gefälligſt, daß folgende Wechſel richtig eingegangen ſind:

fs. 700	per 25 ulto.	auf Grenoble.
„ 300	„ 28 „	
„ 2,000	„ 31 „	
„ 5,000	„ 31 „	„ St. Etienne.

welche Beträge wir Ihrem Conto gutgebracht haben.

Hochachtungsvoll,

M. Berthou & Co.

ARCHITECTURE.—VII.

[Continued from p. 140.]

THE ROMANESQUE STYLE.

It becomes necessary now to retrace our steps to the fourth century in order to follow the early development of the Romanesque style.

The term "Romanesque" is the broad title given to all those forms of Christian architecture in the west of Europe in which the round arch and the plain and intersected barrel vaults form the chief distinctive features. The archaic period of the style commences with Rome, and the class of structure adopted is that on which Constantine based his earlier churches—viz., the Roman basilica—but with these important differences: first, the tradition of building still existed in Rome of a debased kind but retaining the tradition of the old style; secondly, the early Christians could either appropriate the ancient Roman buildings, or, pulling them down, could use up their old materials as well as those of numerous other buildings no longer required. The plan of the basilica was adopted, not because there were disused buildings of that class to make use of, but because it (the plan) was the most convenient for the services of the new religion. The great central aisle or nave served for the male worshippers, the women being placed in the aisles or in the galleries on an upper storey over them; the cross aisles or colonnades between the nave and the apse were omitted and their place was taken by an immense arch opening into the nave; the apse in which the court of justice held its sittings was admirably suited for the altar and for the bishops and priests, and all that was necessary was to raise the floor of this apse, so that the altar and the ceremonies of the church could be seen well from the farther ends of the nave and aisles The first basilican church built, now destroyed, was that of St Peter, the altar of which was under the dome of the present cathedral, commenced in the middle of the fifteenth century This church consisted of an entrance porch, an atrium surrounded by a colonnade with a fountain in the centre for ablutions (the origin of the holy-water stoup inside Roman Catholic churches), a narthex or vestibule for penitents, a nave with double aisles on each side, a transept to give more space for the clergy and for additional altars, and an apse with a screen of twelve columns A similar plan exists in the church of St. Paul outside the walls of Rome, except that the transept, being of unusual width, is divided by a wall of piers and columns to assist in carrying the roof. This was, therefore, the typical plan of the new Christian church. As regards orientalism, of about fifty churches in Rome ten have their altars at the east end of the church, the others at the west end, so that in this respect the latter followed the tradition of the earlier churches erected in the East by Constantine and his followers

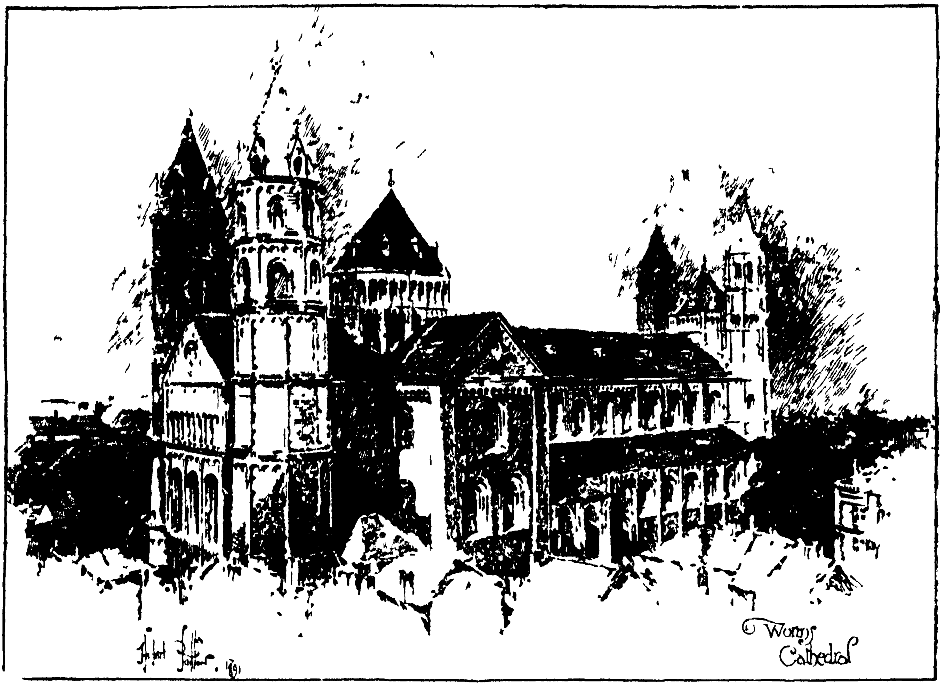

Fig 24 —WORMS CATHEDRAL. (*From a Photograph by Frith and Co, Reigate*)

Many of these early churches were built with materials taken from other buildings, and therefore, virtually, there could be no great development of style After a time, the columns which separated the nave from the aisles, instead of supporting architraves, carried arches on which the wall above was built The church of St. Clement, Rome, is an excellent example; it retains still its atrium, and there are galleries along the aisles, both separated from the nave by arches carried on columns; the light being admitted to the church through clerestory windows in the wall above All of these churches were roofed in timber, excepting the apse, which was covered with a hemispherical vault, the soffit of which was decorated with figures all on gold backgrounds in mosaic, a type of decoration brought from

Byzantium and probably at first executed by Byzantine artists.

The first real development of the Romanesque style takes place in Germany and in the north of Italy, under the reign of Charlemagne and of his successors in the ninth and tenth centuries. Very little remains of this period, but there is sufficient to show that the basilican type of church was adopted for the plan, the floor of the eastern apse being raised to allow of a crypt below, and externally a scheme of wall decoration which in the eleventh and succeeding centuries received further development. This decoration consists in the breaking up of the wall surface by flat bands or pilasters at regular intervals, interrupted by horizontal bands in the towers marking the level of the floors inside, the lower side of these bands being cut into a series of diminutive arches evidently in imitation of the classic arcade (Fig. 23).

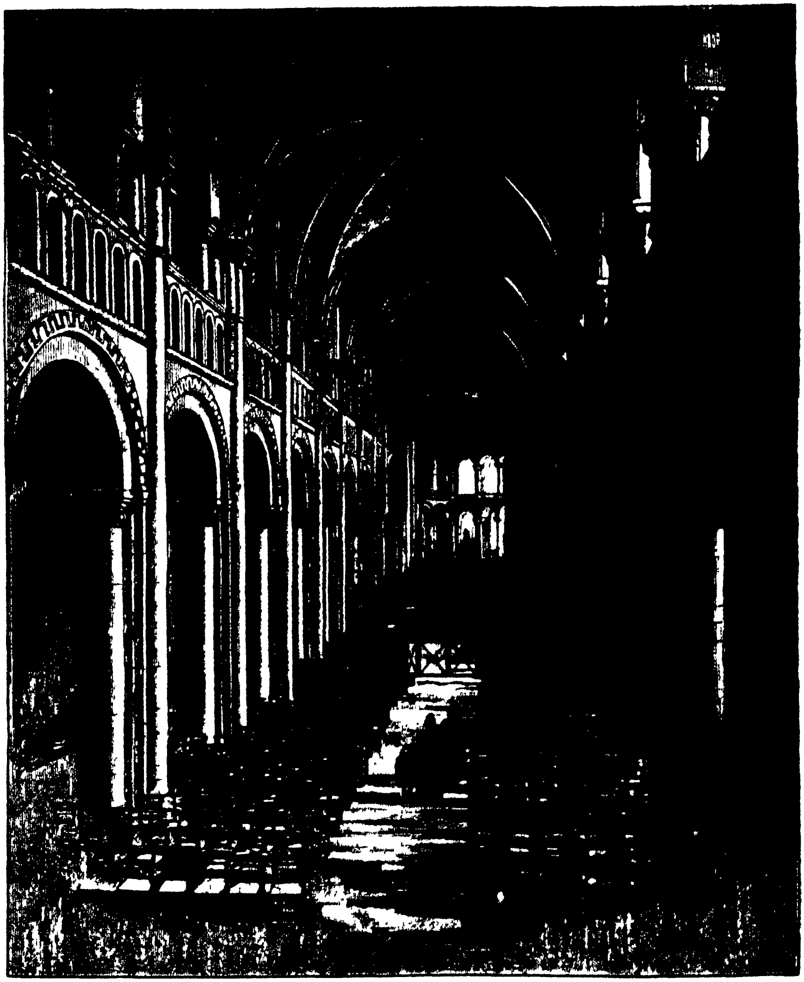
Fig. 25.—The Abbaye-aux-Dames, Caen.

Shortly before the close of the tenth century, the scare which filled men's minds as to the approaching millennium caused a general apathy among church-builders. A few more years passed and then the various Christian nations shook off their torpor and vied with one another in the erection of important buildings, on a larger and more important scale than those hitherto carried out.

The same desire, as pointed out in the lesson on Byzantine architecture, that in the sixth century led the Emperor Justinian to produce churches the roofs of which should be vaulted, obtained also in Western Europe. The change was made timidly at first, the aisles only being vaulted and the naves and transepts retaining their timber roofs, but it gradually extended to the whole of the building. The adoption of vaults, however, introduced some changes into the plan. The comparatively slender columns, which sufficed to carry the walls of the nave with a timber roof, were not strong enough to carry the weight, or thick enough to resist the thrust, of a vault. We find them therefore replaced by square piers (as at St. Albans), or by circular columns of immense size (as at Durham), or by a combination of the two, viz., piers and semi-detached columns or shafts. A change takes place in the arches also—instead of being simply square in section, they are divided into two or more orders as they are called, the inner or lower arches being set back or recessed behind the centre rings. It was this recessing of the orders that may have led to the subdivision of the piers, the semi-detached columns carrying the inner rings or orders. Certain changes also were made in the vault: the Roman vault consisted of plain intersecting barrel vaults; to this the Romanesque builders added transverse ribs thrown across the nave, and having once stopped the continuity of the barrel vault, in each compartment of the nave, they raised the centre of the vaulting to give increased strength and possibly lighter appearance. The aisles had generally been made half the width of the nave; and as the compartments of both nave and aisles were made square in plan, it followed that there were two compartments of the aisles to one of the nave. Those piers which carried the transverse ribs of the nave had to be made larger and more important than the intermediate piers which had only the transverse rib of the aisles to carry; the alternate piers were therefore dissimilar, the intermediate pier having comparatively little work to do. This was in a measure obviated by carrying an intermediate supplementary transverse rib across the square compartment of the nave (Fig. 24), dividing it therefore into six parts, and consequently called sexpartite instead of quadripartite. The final solution of the problem was not scientifically resolved till the use of the pointed arch came in, to which we shall return in our next lesson.

We must now return to the earlier buildings built in the early part of the eleventh century, and trace their development in each country till the introduction of the pointed arch.

The church of St. Miniato near Florence, built 1014 A.D., a basilican church with timber roofs, is one of the earliest examples. On the arcade which carries the nave walls the place of every third column has been taken by a pier which supports a transverse arch in stone thrown across the nave—this may be said to be the first step taken towards stone construction of the roof. Another example of this is found in St. Prassede at Rome. The floor of the eastern compartment of the three bays of St. Miniato (the bays being emphasised by the stone arches referred to), and of the apse is raised to allow of a crypt beneath. The interior of the church is lined with white marble with geometrical patterns formed by inlays of black marble bands. The same decoration is employed for the exterior, but in addition we find in the chief front on the lower storey a series of five blind arcades, viz., arches carried on semi-detached columns, but filled in by the wall; and above, the higher portion representing the nave is decorated with four pilasters carrying a flat band which represents the entablature. We find, therefore, features which are Roman in their origin, but which are here treated decoratively in the Romanesque manner. In the cathedral of Novara, and in St. Ambrogio of Milan, both in Lombardy, the influence of the Lombardic style is pre-eminent, and the trammels of the Roman style are almost entirely thrown off. The semi-detached columns of St. Miniato have become long and attenuated shafts, or have been replaced by long vertical bands which rise from top to bottom of the front, cutting through the horizontal lines, which are thus subordinated. These two churches are also vaulted, retaining the square compartments in both nave and aisles, and with piers of dissimilar dimensions. It is in the cathedral of Pisa, built in the latter half of the eleventh century, that we find a far greater development in the sumptuous decorations of the exterior. The whole is cased with white marble with bands of black marble intervening. There is a blind arcade round the lower portion of the walls of the cathedral, but the arcades are loftier, the shafts or semi-detached columns of lighter proportions, and the carving more Greek than Roman. Above these in the front are four rows of arcades superimposed, forming as many galleries; the sides of the second row are made to fit the sloping roofs over the aisle galleries, and those of the fourth or top row the roof of the nave. On the sides and round the rest of the building (except in the apse, where they form extended galleries again) the arcade is carried round as a blind arcade.

The same influence to which we have referred as being exerted on the churches in North Italy likewise extended to those built in the Rhenish provinces, with this exception, that being more distant from the centre of Roman art, they were less classic in their detail, though the desire to build after the Roman manner and to reproduce to their best powers what they thought were Roman details, is clearly evidenced by the work in most early churches, as in Quedlinburg in the Harz, and at Paderborn in Westphalia.

The great typical examples of Rhenish architecture are the cathedrals of Spires, Worms (Fig. 24), and Mayence—the last has been so completely reconstructed that its original plan is doubtful. The cathedral of Spires is one of the largest European cathedrals, and covers an area of 57,000 square feet, its length being 435 feet, and its nave 45 feet wide and 105 feet high—greater dimensions than those of any other Romanesque church. It consists of a narthex, nave and aisles, transept, and choir with apse. Though founded in 1030, it is quite certain that its nave vault must have been originally covered with a timber roof, for no architect would have been capable at that period of throwing a vault across a nave of 40 feet span. There are six square bays in the nave, and, as usual, twice that number in the aisles. Externally it is of extremely simple design, and owes its effect chiefly to its solidity and its size, and to the variety given to it by its towers. It is in this respect that the Rhenish cathedrals differ from those in Italy, obtaining their effect by the variety of sky-line given by their lofty towers and the projection of their western and eastern transepts. In this respect the cathedral of Worms, with its four circular towers, two on either side of its eastern apse (which is circular inside only), and two on either side of the western choir, and with a central octagonal tower over the crossing of nave and transept, constitutes a picturesque and varied outline which gives much character to the church. There are three churches in Cologne in which we find a special feature at the east end, viz., the church of St. Maria in Capitolio, the churches of the Apostles and of St. Martin. In each case the transept as well as the choir is terminated by an apse. The grouping of this triapsal arrangement externally is very fine, especially in the Apostles' church, where two lofty octagonal towers are placed at the point of junction of the apses. At Bonn, Laach, Andernach on the Rhine, Limburg on the Lahn, and at Bamberg in Bavaria, we find other examples in which towers and octagonal lanterns constitute extremely fine and picturesque groups.

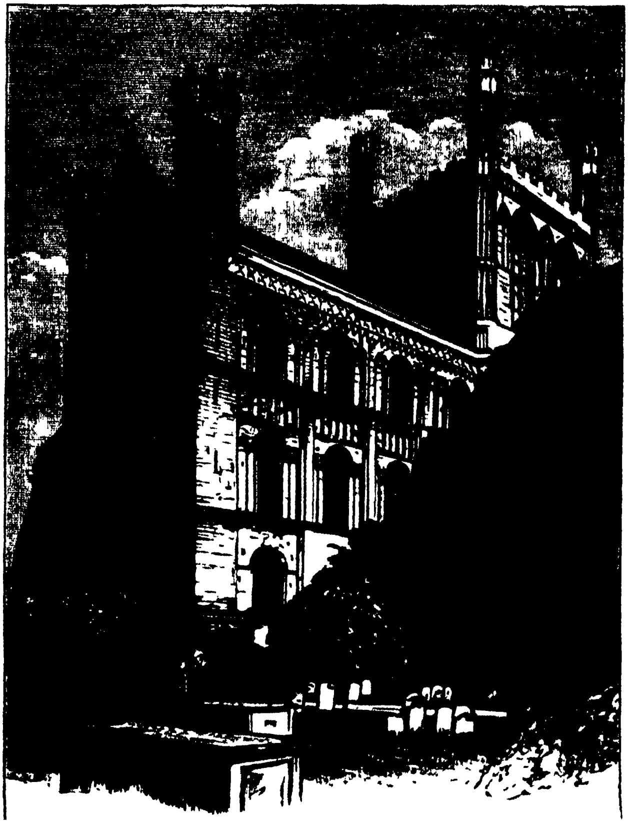

Fig. 2 .—PETERBOROUGH CATHEDRAL.

In all these churches we find very much the same arrangement of plan, all being of the basilican type with such modifications as the introduction of vaulting brought. When, however, we pass on into

France, we find ourselves in the presence of very varying conditions, owing to the fact that up to the thirteenth century that country was divided into a number of provinces, rendering their allegiance to different chiefs, with customs and with influences in most cases entirely contrasting one with the other. In the province of Aquitaine for instance, owing to the settlement of a colony of Greeks and Venetians towards the end of the tenth century at Limoges, we find at St. Front, Perigueux, already referred to, a church built in imitation of St. Mark's at Venice, with five domes covering its nave, transept, and choir. The influence of this exotic feature is found throughout the province, and consequently the churches there, and which were subsequently built in the eleventh, twelfth, and thirteenth centuries, are modified in their plan; and we find a series of churches without aisles, but with three bays to the nave, which, with the transept and choir, gives in plan the form of a Latin cross instead of the Greek cross of St. Mark's and St. Front. Farther north, in the Angiovine province, a similar plan is retained, *i.e.*, without aisles; but instead of the dome we find quadripartite vaults rising so high at the crown that were it not for the diagonal ribs they might be taken for domical forms (the Trinité at Angers) The influence of the dome is again found in Burgundy—treated, however, in an entirely different way—as at Le Puy-en-Velay, where the nave is vaulted with octagonal domes all with ribs

The greatest church of the province of Burgundy was the abbey church of Cluny, now destroyed It was 580 feet long, a greater dimension than any other French church, and had a narthex, ante-chapel, nave, and double aisles, principal transept with eastern chapels, a choir with eastern transept, eastern chapels, and a chevet, that is to say, a group of five chapels at the east end, an arrangement to which we shall refer again when we come to the great Gothic cathedrals of France. The churches of Notre-Dame-du-Port at Clermont, and those of Issoire, Brioude, and others in Auvergne, are remarkable for the external decoration applied to them by the use of lava of different colours, which are employed in geometrical patterns as a wall decoration.

The province which possesses the greatest interest, however, so far as we are concerned, is that of Normandy, from which our own Norman style was derived, having been introduced (at all events in its extended development, for its influence had previously been felt) by William the Conqueror. The great abbey churches which he built at Caen, the church of St. Stephen, known as the Abbaye-aux-Hommes, and La Trinité, or the Abbaye-aux-Dames (Fig. 25), being the two types on which most of our English architecture was founded; with certain distinctions to which we shall draw attention. The earlier portion of the church of St. Stephen, founded in 1064, has been replaced by the Gothic choir of the thirteenth century, but the west front, the nave, aisles, and transept date between 1073–1089. It is probable that the nave was, as in our cathedrals of Peterborough and Ely, originally covered with a timber roof, and that in the twelfth century this was replaced by the vault which still exists The bays of the nave were originally square with four diagonal ribs, intermediate ribs were then added which constituted the sexpartite vault already described.

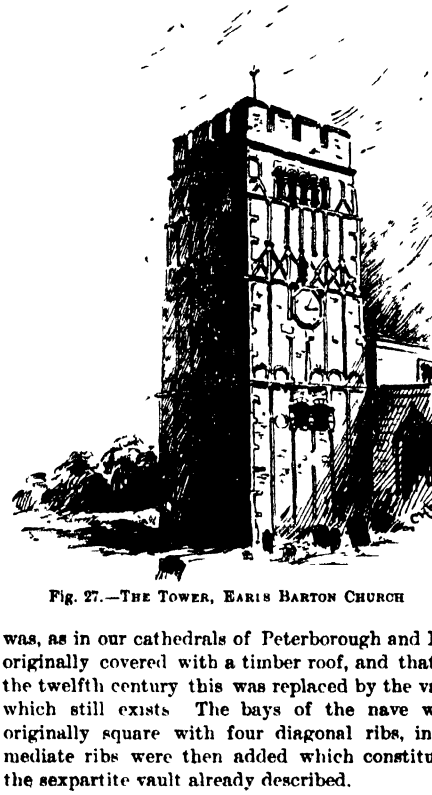

Fig. 27.—The Tower, Earls Barton Church

Passing now over to England, the term Saxon is given to all those church buildings which were erected in Great Britain prior to about the middle of the eleventh century. They are distinguished by the rudeness of their building, by the construction of the quoins and angles of the walls with what is known as long and short work, which consists of large horizontal courses of stone of shallow depth alternating with high upright blocks placed at the angles; we find also an attempted imitation of Roman or Lombardic arcades and shafts covering the wall surface and of Roman balusters in the windows. The tower of Earls Barton church may be taken as a typical example (Fig. 27).

The most extraordinary activity was displayed by William the Conqueror and his successors in the foundation and erection of important cathedrals throughout England. In fact there are no fewer than twenty of our cathedrals which possess still some features which prove the antiquity of their foundation. The most important of those which retain still a considerable part of their Norman features are Norwich, Peterborough (Fig. 26), Ely, St. Albans, Durham, Oxford, Gloucester, Rochester, Chichester, Canterbury, Hereford, and Southwell.

The distinctive feature which characterises some of these in comparison with French examples is the huge cylindrical pier in the place of the pier with attached shafts. These are found in Hereford, Gloucester, Durham, Norwich, Oxford, and Rochester. Similar features are found at Tewkesbury and Waltham Abbeys, the latter claimed to be anterior to the Norman Conquest, and if so of especial interest as showing that we retained one essentially Saxon feature. The vaulting also, especially of the nave, was not introduced till much later than in France, and many of our cathedrals still retain their timber roofs with flat-boarded ceiling, those of St. Albans, Ely, and Peterborough being fine examples.

Besides the cathedrals there still exist a very large number of churches and abbeys: Waltham and Tewkesbury, already mentioned; portions of Christchurch Priory; St. Cross, Winchester; and Romsey Abbey in Hants; and in London of St. Bartholomew's Church, Smithfield. Of castles those at Rochester, Castle Rising in Norfolk, Newark, Colchester, and others, and also here in London the White Tower built by Bishop Gundulph in 1081, which is the first completed vaulted structure, *i.e.*, with nave and aisles roofed in stone, which we possess in this country.

Scotland is also rich in Norman work, the round-arched style in that country being of longer duration than in England. On the whole, the most remarkable features found of the style in this country are the magnificent doorways, with their many orders and rings of arches recessed one behind the other, and richly carved with geometrical and other ornament.

The chief characteristic of the Norman style in England is its great massiveness and solidity, sometimes retaining its rich carving for the doorway and windows, and sometimes spreading it over the surface in blind arcades extremely vigorous in their light and shade, as in the cathedral of Peterborough and in the magnificent south-west tower of Ely, which with what remains of the original front, constitutes one of the finest compositions of the Norman style.

GREEK.—XVI.

[*Continued from p. 184.*]

VERBS PURE, IMPURE, AND LIQUID—UNCONTRACTED VERBS PURE.

THE student has now obtained some general knowledge of the Greek verb. If he has accurately acquired what has been set forth, he will be able to construe the simpler forms of the language. Let him make trial as to what he can do, and so test his progress, by putting into English a few verses of the first chapter of the Gospel according to St. John.

THE GOSPEL OF ST. JOHN, I. 1–10.

1. Ἐν ἀρχῇ ἦν ὁ λόγος, καὶ ὁ λόγος ἦν πρὸς τὸν Θεόν, καὶ Θεὸς ἦν ὁ λόγος. 2. Οὗτος ἦν ἐν ἀρχῇ πρὸς τὸν Θεόν. 3. Πάντα δι' αὐτοῦ ἐγένετο, καὶ χωρὶς αὐτοῦ ἐγένετο οὐδὲ ἕν. 4. Ὃ γέγονεν ἐν αὐτῷ ζωὴ ἦν, καὶ ἡ ζωὴ ἦν τὸ φῶς ἀνθρώπων. 5. Καὶ τὸ φῶς ἐν τῇ σκοτίᾳ φαίνει, καὶ ἡ σκοτία αὐτὸ οὐ κατέλαβεν. 6. Ἐγένετο ἄνθρωπος ἀπεσταλμένος παρὰ Θεοῦ, ὄνομα αὐτῷ Ἰωάννης. 7. Οὗτος ἦλθεν εἰς μαρτυρίαν, ἵνα μαρτυρήσῃ περὶ τοῦ φωτός, ἵνα πάντες πιστεύσωσι δι' αὐτοῦ. 8. Οὐκ ἦν ἐκεῖνος τὸ φῶς, ἀλλ' ἵνα μαρτυρήσῃ περὶ τοῦ φωτός. 9. Ἦν τὸ φῶς τὸ ἀληθινὸν ὃ φωτίζει πάντα ἄνθρωπον ἐρχόμενον εἰς τὸν κόσμον. 10. Ἐν τῷ κόσμῳ ἦν, καὶ ὁ κόσμος δι' αὐτοῦ ἐγένετο, καὶ ὁ κόσμος αὐτὸν οὐκ ἔγνω.

Verse 3. **Ἐγένετο**, *became or were produced*, the second aorist (like ἐλίπετο) indicative, third person singular, from γίγνομαι, *I become*.

5 **Σκοτία, -ας, ἡ**, *darkness*; φαίνω, *I show, I shine*, generally in the classics used transitively, here intransitively.—**Κατέλαβεν**. The student will recognise κατ as a shortened form of κατά, *down*, the α being elided before the following ε: ε is the syllabic augment; ν is placed at the end of the word for the sake of sound; so that removing ν we have left ἔλαβε. Compare ἔλαβε with ἔλιπε, and it will be seen that it is the third person singular of the second aorist indicative active (of the verb λαμβάνω, *I take*). Compounded with κατά, the verb signifies *I take hold of, I apprehend, I am aware of*.

6. **Ἀπεσταλμένος** is a participle of the passive voice; cut off the participial termination -μενος, and we have απεσταλ. Απ is the preposition ἀπό, *from*. What, then, is εσταλ? The form is the tense-stem of the perfect passive or middle of the verb στέλλω, *I send*, which is the root of the term ἀπόστολος, *an apostle*. **Ἀπεσταλμένος** therefore signifies *sent*.

7. **Ἦλθεν**, *came*, is the second aorist, third person singular, indicative active, of the irregular verb ἔρχομαι, *I come*. **Μαρτυρία, -ας, ἡ**, *a testimony*, from μάρτυρ, -υρος, ὁ, *a witness* (hence our *martyr*); and

μάρτυρ is the root of the verb μαρτυρέω, *I bear witness.* The form in the text—namely, μαρτυρήσῃ—is the third person singular, first aorist, subjunctive; πιστεύσωσι (root πίστις, -εως, ἡ, *faith*), the third person plural, first aorist, subjunctive, from πιστεύω, *I believe.*

9. Φωτίζει (root φῶς, -ωτός, τό, *light*), the third person singular, indicative mood, present tense, of the transitive verb φωτίζω, *I throw light on, I enlighten.* Ἐρχόμενον will be recognised as the participle present of the verb ἔρχομαι, explained in verse 7.

10. Ἔγνω is much like our English word *know.* The ε is the syllabic augment, γνω is the root of the verb, and ἔγνω is the third person singular of the second aorist indicative active, *knew.*

FORMATION OF TENSES OF VERBS IN -ω.

Verbs in -ω are divided into two classes, according to their characteristics (that is, the nature of the letter immediately preceding the -ω of the first person singular). These classes are—

(1) *Pure Verbs*, whose characteristic is a vowel. Pure verbs are further divided into two divisions:

- (*a*) *The Uncontracted*, whose characteristic is any vowel except α, ε, ο, as:—λύ-ω, *I loose;* βουλεύ-ω, *I advise.*
- (*b*) *The Contracted*, whose characteristic is either α or ε or again ο, as:—τιμά-ω, *I honour;* φιλέ-ω, *I love;* μισθό-ω, *I let for hire.*

(2) *Impure Verbs*, whose characteristic is a consonant. Impure verbs are divided into two divisions:

- (*a*) *Mute Verbs*, whose characteristic is one of the nine mutes, π, κ, τ, β, γ, δ, φ, χ, θ, as:—λείπ-ω, *I leave;* πλέκ-ω, *I weave;* πείθ-ω, *I persuade.*
- (*b*) *Liquid Verbs*, whose characteristic is one of the liquids, λ, μ, ν, ρ, as:—ἀγγέλλ-ω, *I announce;* νέμ-ω, *I divide;* φαίν-ω, *I show;* φθείρ-ω, *I corrupt.*

FORMATION OF THE TENSES OF THE VERBS PURE.

In pure verbs, the contracted as well as the uncontracted, the tense-ending in general connects itself with the unchanged characteristics; as λυ-, λύ-σω, λέλυ-κα. Pure verbs form no second, but only first, tenses; the perfect they form with -κ (-κα), the future and the aorist with -σ and -θ (-σω, -σα, -θην, -θησομαι). The pure verbs, however, are subject to this regular change: the short vowel of the present and the imperfect, in uncontracted as well as contracted verbs, is lengthened in the other tenses. We speak first of

THE UNCONTRACTED.

ῐ into ῑ, μηνί'-ω, *I am vexed with;* f. μηνῑ'-σω, a. ἐ-μήνῑ-σα.

ῠ into ῡ, κωλῠ'-ω, *I hinder;* f. κωλῡ'-σω, a. κε-κώλῡ-κα.

THE TENSES OF κωλῠ'ω, *I hinder*.

Active.

Present κωλῠ'-ω, imperf. ἐ-κώ-λῠ-ον, —ῠ.
Future κωλῡ'-σω, 1 aor. ἐ-κώλῡ-σα, inf. κωλῦ-σαι, —ῡ.
Perfect κε-κώλῡ-κα, plup. ἐ-κε-κωλῡ'κη, —ῡ.

Middle.

Present κωλῠ'-ομαι, imperf. ἐ-κωλῠ-όμην, —ῠ.
Future κωλῡ'-σομαι, aor. ἐ-κωλῡ-σάμην, —ῡ.
Perfect κε-κώλῡ-μαι, perf. fut. κε-κωλῡ'-σομαι, plup. ἐ-κε-κωλῡ'-μην, —ῡ.

Passive.

Aorist ἐ-κωλῡ'-θην, fut. κωλῡ-θήσομαι, —ῡ.

Contrary to the rule, several pure verbs retain the short characteristic vowel either in all the tenses or in some of them. These verbs take a σ in the perfect and pluperfect middle or passive, as well as in the first aorist and future passive; also in their verbal adjectives. This peculiarity is observed by several other verbs, which either have a long vowel in the root, or lengthen in the tenses a short vowel in the root, as:—ἀκούω, *I hear;* ἐναύω, *I set on fire;* θραύω, *I break in pieces;* κρούω, *I dash;* ψαύω, *I touch;* σείω, *I shake;* κελεύω, *I command;* λεύω, *I stone;* κλείω, *I shut;* πταίω, *I knock against;* χρίω, *I smear.* This fact is indicated thus—pass. with σ:—

Χρῐ'ω, *I sting*, fut. χρῐ'σω, aor. ἔχρῐσα, inf. χρῐ'σαι; pass. with σ. But,

Χρῑ'ω, *I rub, anoint*, fut. χρῑ'σω, aor. ἔχρῑσα, inf. χρῖ'σαι, aor. mid. ἐχρῑσάμην; perf. pass. κέχρισμαι; inf. κεχρῖσθαι; 1 aor. ἐχρίσθην, verb. adj. χριστός.

Ἀνῠ'ω, *I complete*, fut. ἀνῠ'σω, aor. ἤνῠσα, inf. ἀνῠ'σαι; pass. with σ.

Ἀρῠ'ω, *I draw*, fut. ἀρῠ'σω, aor. ἤρῠσα, ἠρῠσάμην; pass. with σ.

Μύω, *I close* (*e.g.*, the eyes), fut. μῡ'σω, aor. ἔμῡσα, perf. μέμῡκα, *I am closed, I am silent.*

Πτῠ'ω, *I spit*, fut. πτῠ'σω, aor. ἔπτῠσα; pass. with σ.

The following dissyllabic verbs in -υω lengthen the characteristic vowel in the future active and middle, the third future, and the aorist active and middle; and δύω also in the perfect and pluperfect active; but in the perfect and pluperfect active (except δύω) and middle, or passive, and in the aorist and future passive, resume the short vowel, thus:—

	Future.	*Aorist.*	*Perfect.*	*Aor. Pass.*
Δύω, *I enter*	δῠ́σω	ἔδῡσα	δέδῠκα, δέδῠμαι	ἐδῠ́θην.
Θύω, *I sacrifice*	θῠ́σω	ἔθῡσα	τέθῠκα, τέθῠμαι	ἐτῠ́θην.
Λύω, *I loose*	λῠ́σω	ἔλῡσα	λέλῠκα, λέλῠμαι	ἐλῠ́θην.

Παύω, *I cause to cease*, has the perfect middle or passive πέπαυμαι, but aorist passive ἐπαύσθην.

Κελεύω, *I order, command*—PERFECT MIDDLE OR PASSIVE.

		Indicative.	*Imperative.*
Sing.	1.	Κε-κέλευ-σ-μαι.	
	2.	Κε-κέλευ-σαι.	κε-κελεύ-ου.
	3.	Κε-κέλευ-σ-ται.	κε-κελεύ-σθω.
Dual.	2.	Κε-κέλευ-σ-θον.	κε-κέλευ-σθον.
	3.	Κε-κέλευ-σ-θον.	κε-κελεύ-σθων.
Plur.	1.	Κε-κελεύ-σ-μεθα.	
	2.	Κε-κέλευ-σθε.	κε-κέλευ-σθε.
	3.	Κε-κέλευ-σ-μένοι εἰσί.	κε-κελεύ-σθωσαν.

PLUPERFECT.

Sing.	1.	Ἐ-κε-κελεύ-σ-μην.
	2.	Ἐ-κε-κέλευ-σο.
	3.	Ἐ-κε-κέλευ-σ-το.
Dual.	2.	Ἐ-κε-κέλευ-σ-θον.
	3.	Ἐ-κε-κελεύ-σ-θην.
Plur.	1.	Ἐ-κε-κελεύ-σ-μεθα.
	2.	Ἐ-κε-κέλευ-σθε.
	3.	Ἐ-κε-κελευ-σ-μένοι ἦσαν.

AOR. PASS. Ἐκελεύ-σ-θην.
FUT. PASS. Κελευ-σ-θήσομαι.

VOCABULARY.

Αἰσθάνομαι (with gen. or acc.), I am aware of, I perceive.
Ἀσπίς, -ῐ́δος, ἡ, a shield.
Δεινῶς, greatly, fearfully, exceedingly.
Δρόμος, -ου, ὁ, a running.
Δύναμις, -εως, ἡ, power.
Καταπαύω, I terminate, bring to an end.
Σεισμός, -οῦ, ὁ, an earthquake.

EXERCISE 87.

Translate into English:—

1. Οἱ στρατιῶται πρὸς τοὺς πολεμίους πορεύεσθαι ἐκελεύσθησαν. 2. Σπάρτη ποτὲ ὑπὸ σεισμοῦ δεινῶς ἐσείσθη. 3. Ἡ τῶν Περσῶν δύναμις ὑπὸ τῶν Ἑλλήνων τέθραυσται. 4. Οἱ πολέμιοι εἰς τὴν ἄκραν κατεκλείσθησαν. 5. Ὅτε οἱ βάρβαροι τῶν ἀσπίδων πρὸς τὰ δόρατα ὑπὸ τῶν Ἑλλήνων κεκρουσμένων ᾐσθάνοντο, δρόμῳ ἔφευγον. 6. Ὁ πόλεμος κατεπαύσθη. 7. Ἐλπίζομεν πάντα εὖ ἀνῠ́σειν. 8. Εἴθε πάντα καλῶς ἀνῠ́σαιμι. 9. Ἡ συνθήκη ὑπὸ τῶν βαρβάρων λέλῠται.

EXERCISE 88.

Translate into Greek:—

1. The soldiers have been commanded to go against the enemy. 2. Our city has been broken by an earthquake. 3. That city will be broken by an earthquake. 4. The city is shaken (pres.) by an earthquake. 5. The power of the Persians was broken by the Greeks. 6. The enemy (plur.) has been shut up in the citadel. 7. The shields were struck against the spears by the enemy. 8. The war has been made to cease (*terminated*). 9. The war will have been terminated. 10. May we complete all things well! 11. To command is easier than to complete. 12. The treaty will be broken by the enemy.

ETYMOLOGICAL VOCABULARY.

The word στρατιώτης is connected with numerous terms, of which we give a list below. The root is στρατ-, which is found in its simplest form in the noun στρατία, *an army*, and the root στρατ- (compare the Latin *strat-* in *stratum*, from *sterno*) is connected in origin and import with στρώννυμι, *I spread out, I cover*, as a camp occupies a field; so that στρατός is properly *a camp*, or an organised army, and στρατία an embattled troop.

Στρατία, -ας, ἡ, an army.
Στρατίαρχος, -ου, ὁ, a leader of an army (αρχος, *a leader*).
Στράτιος, relating to an army.
Στρατιώτης, -ου, ὁ, a soldier.
Στρατιωτικός, relating to a soldier.
Στρατιῶτις, -ιδος, ἡ, a ship for transporting soldiers.
Στρατόπεδον, -ου, τό, a camp, an army in camp, an army.
Στράτευμα, -ατος, τό, an army.
Στρατευσείω, I desire war.
Στράτευσις, -εως, ἡ, army-service.
Στρατεύω (more common στρατεύομαι), I serve in the army.
Στρατηγέω (ἄγω, *I lead*), I lead an army, I am a general.
Στρατηγία, -ας, ἡ, the office of a general.
Στρατηγικός, relating to a general's office.
Στρατηγός, -ου, ὁ, a general.

CONTRACTED VERBS PURE.

Contracted pure verbs are those which have for their characteristic either α, ε, or ο, and blend those vowels with the immediately following mood-vowel. The mixing of the vowels takes place in only the present and imperfect of the active and middle (or passive), since only in those two is the characteristic vowel followed by the mood-vowel.

The blending of two vowels produces various vowels or diphthongs, according to the rules laid down above (p. 22). We may present them in tabular form as follows:—

VOWEL CONTRACTIONS.

α + ε = ᾱ.
α + η = ᾱ.
α + ῃ = ᾳ.
α + ει = ᾳ.
α + ο = ω.
α + ω = ω.
α + ου = ω.
α + οι = ῳ.

ε + ε = ει.
ε + ει = ει.
ε + η = η.
ε + ῃ = ῃ.
ε + ο = ου.
ε + ου = ου.
ε + ω = ω.
ε + οι = οι.

ο + ο = ου.
ο + ε = ου.
ο + ου = ου.
ο + ω = ω.
ο + η = ω.
ο + ῃ = οι
ο + οι = οι.
ο + ει = οι (ου in the infin.).

From this tabular view it will easily be seen how to resolve the contracted forms into the uncontracted. In order to do so, we have only to reverse the process.

By consulting the table, you will find that the double vowels and diphthongs have each several values. Accordingly, when you meet with ω, so as to give you an idea that it is a contracted form, you know that its elements must be found in the list of its equivalents just given. The same may be said of ου and οι.

The contracted verbs agree with the uncontracted verbs in this—namely, that generally the characteristic root-vowel of the present and imperfect is lengthened in the other tenses. Thus we change—

ε into η, as φιλέ-ω, *I love* fut. φιλή-σω.
ο ,, ω ,, μισθό-ω, *I let for hire* ,, μισθώ-σω.
ᾰ ,, η ,, τιμά-ω, *I honour* ,, τιμή-σω.
ᾰ ,, ᾱ ,, ἐᾰ́-ω, *I allow* ,, ἐᾱ́-σω.

This lengthening into ᾱ takes place when the vowel is preceded by ε, ι, or ρ, as:—

Ἐᾰ́ω, *I suffer* fut. ἐᾱ́σω, aor. εἴᾱσα.
Μειδιᾰ́ω, *I smile* fut. μειδιᾱ́-σομαι.
Ἀλοᾰ́-ω, *I strike, thresh* ,, ἀλοᾱ́-σω.
Ἀκροᾰ́-ομαι, *I hear* ,, ἀκροᾱ́-σομαι.

The following, with some others, take η instead of ᾱ:—

Ἐγγυᾰ́-ω, *I pledge* fut. ἐγγυή-σω.
Βοᾰ́-ω, *I shout like an ox* ,, βοή-σομαι.
Χρᾰ́-ω, *I utter an oracular response* ,, χρή-σω.

Observe that λούω, *I wash*, forms from the simpler verb λόω the middle present λοῦται, λούμενος, λοῦ, λοῦσθαι, the imperfect ἐλούμην, ἐλοῦ, ἐλοῦτο, etc. The other parts are regularly formed from λούω.

An example of the way in which contracted verbs are conjugated is subjoined below. This should be carefully committed to memory exactly as it is given here:—

Τιμάω, τιμῶ; τιμάεις, τιμᾷς; τιμάει, τιμᾷ; τιμάετον, τιμᾶτον; τιμάετον, τιμᾶτον; τιμάομεν, τιμῶμεν; τιμάετε, τιμᾶτε; τιμάουσι, τιμῶσι.

Τιμάομαι, τιμῶμαι; τιμαέσθω, τιμάσθω; μισθοέσθων, μισθούσθων; φιλεόμενος, φιλούμενος; ἐφιλεόμεθα, ἐφιλούμεθα; ἐτιμάεσθε, ἐτιμᾶσθε; ἐφιλέοντο, ἐφιλοῦντο, etc.

KEY TO EXERCISES.

Ex. 82. —1. The enemy are making an expedition against our city. 2. We will consult respecting the safety of the citizens. 3. The father told me that he would go. 4. The Greeks made an expedition against the Persians. 5. Let us rest, my friends. 6. Consult well before action. 7. All wish to taste honour. 8. The father will go when he has rested. 9. The gates will have been shut by night. 10. If such a man attends to the constitution, it will have been well cared for (*consulted about*).

Ex. 83.—1. Πεπαιδεύσομαι. 2. Πεφυτεύσονται. 3. Πεφονεύσεται. 4. Ὁ στρατηγὸς ἐπὶ τὴν πόλιν πορεύσεται. 5. Οἱ στρατηγοὶ ἐπὶ τὴν πόλιν ἐπορεύσαντο. 6. Πορεύσαιτο ὁ στρατηγὸς ἐπὶ την πόλιν. 7. Βεβουλευσόμεθα περὶ τῆς σωτηρίας τῆς πατρίδος. 8. Βουλεύσεται περὶ τῆς σῆς σωτηρίας. 9. Περὶ τῆς τῶν πολιτῶν σωτηρίας ἐβουλεύσατο. 10. Ἐπαύσαντο. 11. Πεπαύσονται. 12. Ὠ δύο ἀνθρώπω ἐπαυσάσθην. 13. Παυσόμεθα, ὦ φίλοι. 14. Οἱ φίλοι πορεύονται.

Ex. 84.—1. Hector was slain by Achilles. 2. The two brothers were educated by the same teacher. 3. Many democracies were destroyed by the usurpers. 4. Great fear possesses the citizens lest the treaty should be broken by the enemy. 5. Would that all youths were well educated. 6. Death to thee (*be thou slain*), thou villain. 7. The soldiers are said to have marched into the enemy's land. 8. The enemy, having broken the treaty, are coming to war against us (lit. *are bringing war against*). 9. The robber shall be slain.

Ex. 85 —1. Φονευθήσονται. 2. Ἐφονεύθησαν. 3. Ἐφονεύθη. 4. Δύο στρατιώτα ἐφονευθήτην. 5. Πολλοὶ ἄνθρωποι φονευθήσονται. 6. Παιδευθήσομαι. 7 Παιδευθήσεται. 8. Παιδευθησόμεθα. 9. Παιδευθήσεσθον. 10. Εὖ ἐπαιδεύθην. 11. Ἡ πολιτεία κατελύθη. 12. Ἡ πολιτεία καταλυθήσεται. 13. Ἡ συνθήκη κατελύθη. 14. Αἱ συνθῆκαι καταλυθήσονται. 15. Τῶν συνθηκῶν λυθεισῶν οἱ πολῖται ἐφονεύθησαν. 16. Οἱ λῃσταὶ ἐφονεύθησαν. 17. Οἱ λῃσταὶ φονευθῆναι λέγονται. 18. Ἡ δημοκρατία καταλυθήσεται.

Ex. 86. – 1. I was setting upright. 2. I was playing drunken pranks. 3. I made a disturbance. 4. I have set upright. 5. I was serving. 6. I was living. 7. I was supporting. 8. I was narrating. 9. I have built. 10 I was throwing. 11. I was leading. 12. I have hoped. 13. I have entreated. 14. I have associated. 15. I have lamented. 16. I was praying. 17. I spent. 18. I was following. 19. I had founded. 20. I had taken. 21. It has been dug. 22. I was casting away. 23. I was preparing. 24. I was in a state of displeasure. 25. I have been a benefactor. 26. I have narrated.

POLITICAL ECONOMY.—III.

(Continued from p. 149.)

LAND, LABOUR, AND CAPITAL.

THE requisites of production, as we have said, may roughly be divided into Land, Labour, and Capital. Labour directs the forces of nature and works on the material supplied by nature, with tools and appliances supplied by wealth saved from consumption and stored up to assist in future production. The raw material, which is worked upon, has also been saved for the purpose, and "tools and appliances" must be taken in a sufficiently wide sense to include beasts of burden—which are living tools—as well as machinery. We now propose to speak of some points in the history of these three requisites of production: of the varieties in their productive power, and of their relative importance in history.

The lowest condition of society we know is that of the Australian savage—with no settled habitation, no tools for acquiring subsistence save a few spears, clubs, and boomerangs, no power of continuous labour, and very limited wants. A higher type of society was found among such savages as the North American Indians when first discovered. There were more elaborate weapons, there was more systematic hunting, and there was besides some accumulation of wealth in the form of clothing, occasionally domestic animals and boats, and to some extent in portable materials for their habitations. And there was in some cases a little cultivation of maize, though this food was quite secondary to the meat obtained by hunting. Moreover, there was some "specialisation of function," or division of labour. Most of the continuous and unexciting work of the production of wealth was done, under compulsion no doubt, by the women, or sometimes by enslaved captives. Among higher tribes, such as the Tartars, described by Mr. Wallace in his "Russia," we find a greater degree of accumulation and a more systematic cultivation of the land. The wealth of such tribes consists mainly in horses or cattle. But to some extent the various families of the tribe take up and cultivate what land they require—that is to say, they sow grain on it, reap the grain, and then next year take up fresh land. Now it is in this way that regular cultivation of land arises.

In many parts of the world, in Russia, in India, in Java, cultivation by such tribes and family groups has lasted on to the present day, and individual rights of property in land have never been quite developed; while there is ample evidence that this was the basis of the system adopted in England and Germany through much of the middle ages and in many parts of Europe in early times. We there find what was known as the village community, which, though it presented infinite variety of detail in different places and times, may roughly be described thus:—It was a collection of households related, or supposed to be related, by blood. Each had its own houseplot, which was owned by the family and managed by the father (or if he died, by the eldest male) as a sort of trustee for them. There was common land on which the various households pastured their cattle. Sometimes there were no restrictions as to what number each household might put on; generally there were various and very complicated rules. So also with the forest land, if any, from which each household got its firewood. The arable land of the village was treated as follows:—First, it was divided into three or more large fields, according to the kinds of grain grown. In any given year, one at least of these lay fallow, while on each of the others a different crop was grown. Next year the former fallow field grew a crop; one of the other fields had a rest, and the other one or more were each growing a different crop from the year before. Now these fields were all cut up into plots, usually long strips, and each household owned so many of these plots, not for ever, but for a term of years, perhaps five or ten, after which a fresh distribution was made. Cultivation was usually carried on by the co-operation of all the inhabitants, so that all the strips in each field were ploughed, sown, and reaped about the same time; and it is probable that the number of strips given to each household was in proportion, in some cases, to the number of oxen each lent to the various plough teams. As population increased, a readjustment of the shares was effected.

In Europe this system has been modified in various ways which we can only glance at here. (1) In some places, in very early times, notably in Ireland before the English conquests, there soon arose an inferior class of landholders. The disturbed state of the country and the prevalence of the custom of blood feud (which, when one man has shed another's blood, whether by design or by pure accident, makes it the duty of any of the slain man's relatives to slay the slayer, and so on for ever), produced a class of outcasts. These men could usually only live by going to some other tribe or community than their own and getting land to cultivate, and borrowing the seed-corn and cattle they required, as well as food to support them till harvest. They were strangers, and so were considered fair game for extortion. (2) The chief of the tribe, or at any rate the head of some distinguished family in the village, obtained special rights over the waste land, often for services as leader in war, and sometimes, land being generally plentiful in early times, a special share to cultivate for his own use. Of course he cultivated it by granting it out to the fugitives just mentioned, or by putting slaves or dependents on it, usually requiring them to pay so much produce, or render him so many days' labour a year, or both. Gradually (it would seem) the chief's or lord's power grew at the expense of the people, and the king's, when regular kingship was introduced, also grew.

The village becomes the manor, with "free tenants" who are supposed to render service in war and contribute towards the expenses of warfare; "base" or lower-class tenants, who cultivate land which is supposed to be the lord's, though by usage they also acquire some rights in it, and paying rent in produce, money, or services for it; and a lord, with the duty of governing and protecting the village, who, by way of recompense, is part owner of the base tenant's land and has certain rights—special rights of hunting for instance—in the forest and other common land. And, in many cases, whole villages of serfs seem to have been formed by lords, with the same sort of system of cultivation as in the free villages.

The nearest approaches to this type of village now are in Russia. The "emancipation of the serfs" in 1860 consisted substantially in freeing the peasantry—who had become very much subjected to the lords—from many of their dues and services to them, but giving part of the land they had hitherto enjoyed entirely to the lords by way of compensation. But in most cases the communal system broke up much earlier. In England we find first that the lord generally did not treat with the body of villagers, but with the villagers as individuals (it is not quite clear why), so that the communal bond soon disappeared; next that the introduction of new crops made the old rules about rotation very inconvenient, and that from about 1300 onwards the keeping of sheep was much more advantageous than grain-growing. Now sheep-farming is most profitably carried on by large owners. Thus the lord's interest was to make his own share of the land as large as possible and then to let it to sheep-farmers. Besides, the growth of manufacture gave some of the displaced peasantry work elsewhere. Thus, especially after the Black Death, and in the reigns of Henry VII. and Henry VIII., the land in many parts of England passed from the possession of the labourers. Large landlords arose and the old village community broke up. Still, some common fields existed in England even in this century.

In other cases again, the peasantry stayed on the land, with fixity of tenure, but burdened by oppressive dues to the lords, as in France and Prussia. These dues were abolished in France at the first Revolution, and much confiscated land was sold in small lots. Hence, France is chiefly a country of peasant proprietors. In Prussia much the same effect was produced by peaceful means by the reforms of Stein and Hardenberg early in this century. In South Germany and Switzerland, and it is said in some parts of Italy, there are still plenty of traces of the village community: a village will own lands, and sometimes pay all its expenses out of the rent and divide the surplus among the villagers, and the rules about the use of the common pasture and wood still survive in various complicated forms; but the arable land has always become private property,.

In many parts of Europe that once were Roman another system of land tenure prevails. Under the Roman Empire large landowners often preferred to live in Rome and let their estates to tenants, or leave them in charge of slaves. Probably the tenants got in arrears with their rents and into distress, and the slaves had to be allowed a good deal of liberty and a share in the produce to get them to work well. So the two classes became very like each other, and by the fourth century A.D. we find the land was often cultivated by *coloni*, literally "peasants," who were not free to leave their land, but had fixity of tenure so long as they paid a certain portion of the produce to the landowner. Gradually of course as time went on they became free men, but the system of paying a produce rent lasted on, and such tenants are often found in Southern France and Northern Italy. From Latin words which may be paraphrased as "peasants who go halves," they are called metayers, or "halvers," though the rent they pay is sometimes two-thirds of the produce.

That this is a very natural form of tenure is clear from the fact that it has arisen independently in parts of the United States, where it is known as "farming on shares."

These forms of landholding are important historically, but nobody would seriously propose to restore them now. In the village community even at its best, the strip of the industrious man might be freely sown with the seeds of the weeds his idle neighbour neglected to pull up; the holdings were much divided; there was immense waste of land in the boundaries between them, and traditional customs interfered with any improvement in agriculture. And all forms of produce rent are unsatisfactory: the large landlord of metayer tenants may have no particular use at the moment for another pig or chicken, but they are his and he takes them, and the tenant feels the annoyance of parting with them more than if he paid a fixed sum; and of course it is extremely easy for him to cheat. Besides, neither landlord nor tenant has enough inducement to spend anything on the place, because neither will get all the produce of what he spends. The two have to make terms as to what improvements each shall do, and this is often difficult.

We have said enough to show how unlike the truth is the assumption of political economy, that there are generally three distinct classes, landlords, labourers, and capitalists. But it is worth while making the assumption to compare it with the facts.

As to labour, it is certain that in very early times a class of wage-paid labourers was generally rare. In early Greece we hear of such a class, but in the course of time it gradually was superseded by slaves. In ancient Greece and Rome nearly all manufacture was in their hands, and much of agriculture. Often they did not live in their master's house, but were hired out by him for so much a day; in some trades they had to pay him so much a day out of their earnings and kept the rest for themselves. In mediæval Europe we find a class of wage-paid labourers, both in agriculture and manufactures, but it was not nearly so large in proportion as in modern times. Until the extensive application in manufacture of machinery moved by water-power or steam, that is to say rather after the middle of the last century, manufactures were usually carried on by a number of small masters, mostly with one or two journeymen living in the house. The master worked at his own trade with his hands along with his journeymen and apprentices; the apprentices rose to be journeymen, and the journeymen, if they were thrifty and good workmen, might hope to be small masters themselves some day. The masters in each town (and often the men too) were organised into trade societies or "guilds," and there were very stringent rules as to the number of apprentices and journeymen a master might keep, the way he must behave to them and conduct his business, and so on. Cases indeed are known where the guild fined masters for sending out bad work, and so injuring the reputation of the trade of their town.

The rise of the "factory system" about one hundred and twenty years ago changed all this. It became more profitable to collect the workmen into large factories, with expensive machinery owned by large capitalists. So though much more was produced and more cheaply, to the great benefit of the consumer—and people are apt to forget that everybody is a consumer—the master and workman came to be much farther apart than formerly, and a great stimulus was given to that division of labour which is the most important way of increasing its productiveness.

Division of Labour.—It was one of the great services of Adam Smith that he first showed the extreme importance of this in increasing the produce. In making a pin, he pointed out, there were eighteen distinct operations:—"One man draws out the wire, another straightens it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head; to make the head, requires two or three distinct operations, to put it on is a peculiar business, to whiten the pins another, it is even a trade by itself to put the pins in the paper." In a case he mentions, ten men made between them 48,000 pins in a day. Had each man worked by himself, they would have made "not twenty each, perhaps not one in a day."

The great advantages of this division are usually enumerated as four:—(1) Saving of time lost in passing from one kind of work to another. (2) Improvement of skill, caused by the workman having to do only one thing. (3) The workman, having his mind confined to one sort of work, invents better ways of doing it—new tools or new machines. (4) Each workman can be employed solely on that kind of work he does best.

Probably too much weight has been attached to the first and third of these advantages. Many a man will get slack at one monotonous employment, who will readily turn to another and (while he is fresh) do it well. A waiter in an eating-house does half a dozen different things in two minutes and loses no time; and many of the best machines have been invented by outsiders. Thus the founder of the Peel family, the inventor of some of the first machinery used in the cotton trade, was not a cotton operative, but a country gentleman with a taste for mechanics. A man doing one simple set of actions every day often "gets into a groove" and comes to work like a machine.

It cannot be denied that *for the workman* the division of labour has some disadvantages. The invention of a new machine or process may throw men out of work who can only do one skilled operation now done by the machine. Such men must then become unskilled labourers at a heavy loss in wages. Besides, the man who does one simple set of actions all day has no exercise for many of his faculties, and when faculties are not exercised they decay. The first disadvantage, most probably, the increase of machinery and minuter subdivision will by-and-by remedy. The general principles of machinery are the same in widely different trades. So also are many of the details. When skilled hand labour is replaced by machine tending, a man whose particular machine is superseded can very likely soon learn to manage another somewhat like it. At the end of the War of Secession in America, a rifle manufactory took to making sewing-machines, employing mostly the same operatives, who easily learnt the new trade. As subdivision becomes more minute, the simple operations one workman performs become more like those of another. For the intellectual drawbacks of the subdivision of labour there is no cure but better education and more time for self-culture.

The progressive division of labour as society advances is now seen to be a case of a process which is found through all departments of the animal and vegetable world. The lowest animals have few separate organs, and one part will do the work of another. The common hydra, it is said, may be turned inside out, and the former outside will do the work of the stomach nearly as well as the inside did. As we look gradually higher in the scale of animal life we find better and more centralised organisation combined with progressive specialisation of parts. The lowest animals often "propagate by fission"; a part breaks off and becomes a new animal, and the parts are often very independent, sometimes each has a special heart and circulating system of its own; but we all know what a very slight injury to the great central organs of the higher animals—the brain, heart, lungs, or stomach —may cause disorder throughout the system and even death.

Societies are tending to be specialised and combined much in the same way as the animal organism during its development from lower to higher stages. This is true in the nutritive processes of the society, the production of its wealth or means of life, as well as in its general and political history. Along with the specialisation goes combination and increased mutual dependence of parts. These two processes together are sometimes called by economists "Complex co-operation of labour," of which the division of labour is one aspect.

The *ideal* of the economist is a society which shall cover the whole world, in which each part shall be in close relations with the rest, each country and each man shall produce what they are best fitted to produce, and all countries shall freely exchange goods with each other. Political and other practical difficulties will for years, perhaps centuries, prevent this ideal from being realised. None the less it is to be kept before us as that after which we are as a rule to strive.

That workmen may work at all, however, there must be enough goods in existence to provide them with tools, and with a maintenance while they are at work. And this store of goods is capital. The word capital means "things counted by the head," and was first applied to the oxen used for ploughing. In fact it is the same word as "cattle." The term is now applied to all the machinery, tools, animals, etc., which assist in production, either directly, or indirectly through transport, as a railway and its rolling stock do, or a steamer which brings foreign corn to be converted into flour. And it is also applied to the maintenance of labourers, the food and clothing which are purchased with the wages which their employer pays them. These wages are sometimes said to be "paid out of capital"; it is more correct to say that in the case of "productive labourers" they are *advanced* out of capital, because the amount of wages the employer can afford to give partly depends on what he is likely to make by the sale of the goods produced. Thus in some trades the men will get less wages when business is dull and they are "working for stock" than when they are working to fill an order, because the employer may have to wait a long time before he sells his stock, and prices may go down before he does so.

The accumulation of capital is one of the most striking contrasts between a savage and a civilised state. A tribe of savages—Australians or North American Indians—is really never very far from starvation. If the hunters fail a few times, food becomes scarce at once. And, indeed, though there are times when it is so plentiful that the savage gorges himself till he can hardly move, yet taking one day with another it is permanently scarce—so scarce that many savage tribes habitually destroy many of their female children, so as not to have too many "useless mouths." Even in a civilised state like the Greek cities of Asia Minor, seven centuries before the Christian era, where the inhabitants lived in walled towns, had cornfields, vineyards, and oliveyards, used coined money, and owned slaves, and had plenty of wealth of various kinds, one of their poets described the spring as "the time when all is blooming, but of food there is not enough." Just before harvest, in fact, there was always a short supply of food, and a bad season meant not merely dear bread, but actual famine for rich as well as poor.

APPLIED MECHANICS.—XI.

[*Continued from p. 154.*]

FORCE, MASS, AND VELOCITY—UNIFORM ACCELERATION — MOMENTUM AND KINETIC ENERGY—EXAMPLES.

In the preceding lessons we have kept in view mainly the *practical applications* of the various laws. The student may not, however, care to seek elsewhere for the treatment of what may be regarded as more purely theoretical parts of the subject, and hence in this lesson we intend to discuss some of the most important of the laws of *dynamics*. It is usual to take one foot as the unit of length, and one second as the unit of time.

Velocity is rate of motion, and if uniform—in which case equal distances are passed over in equal intervals of time—it is measured by the distance passed over in one second.

Acceleration is rate of change of velocity, and if uniform—in which case there is an equal gain or loss of velocity in equal times—it is measured by the velocity gained or lost per second. When a body moves with a continually increasing speed its acceleration is said to be *positive*; if, on the other hand, the velocity diminishes, the acceleration is *negative*. We shall here deal only with *uniform* velocity and acceleration. From the statement made above it will readily be seen that if a body moves with a uniform velocity v over a distance s in time t, v must be equal to $\frac{s}{t}$, or $s = v\,t$.

If, for instance, a train moves always at the same rate, its velocity is best obtained by observing the distance moved in a considerable time and dividing the distance by the time. The laws of uniform acceleration can be readily illustrated graphically. Thus in Fig 70 the ordinate A E represents the body's velocity at the beginning, and B D represents its velocity at the end of the interval of time, t, considered.

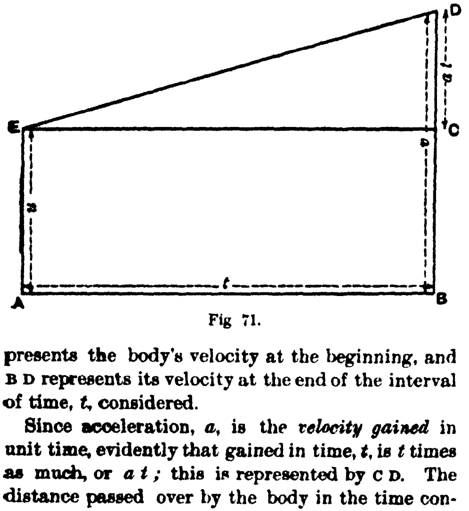

Fig 71.

Since acceleration, a, is the *velocity gained* in unit time, evidently that gained in time, t, is t times as much, or $a\,t$; this is represented by C D. The distance passed over by the body in the time considered is $\frac{1}{2}(u + v)\,t$, or is the *average velocity* multiplied by the *time**; this distance, s, being represented by the area of the figure A B D E, which is equal to the area of the rectangle A B C E + the area of the triangle E C D. Putting these last two statements into algebraic form we have

(1) $v = u + at$

(2) $s = ut + \frac{1}{2}at^2$.

Eliminating the term t from these two equations we get a third

(3) $v^2 = u^2 + 2as$.

It must be understood that in these rules the + sign is replaced by − if the acceleration is *negative*. If, in a particular case, the initial velocity is 0, that is to say, if the body *starts* at the beginning of the interval of time considered, then the rules become

(1) $v = at$

(2) $s = \frac{1}{2}at^2$

(3) $v^2 = 2as$.

A body falling freely under the action of gravity has a uniformly accelerated motion, if we neglect atmospheric friction or suppose it to produce a constant effect. The body in this case *gains* a velocity of about 32 feet per second *every second* of its motion, or, in dynamical language, the acceleration is 32 feet per second per second. This acceleration is usually denoted by the letter g; it varies slightly with the latitude of the place, and also with the height above sea-level. If, then, a body is allowed to fall freely from rest, through a height h, or for a time t, our rules become

(1) $v = gt$

(2) $h = \frac{1}{2}gt^2$

(3) $v^2 = 2gh$.

ACCELERATION, FORCE, AND MASS.

If you throw a leaden bullet and a piece of cork of the same size, the bullet goes farther than the cork because it possesses more of that something formerly called *inertia*, now generally termed *mass*. The *mass* of a body is usually defined as the quantity of *matter* in it. What matter really is we cannot explain; it has nothing to do with bulk, but the earth pulls more at a body the greater the quantity of this mysterious matter in it. In fact, there is a *mutual* pull between the earth and the body, this pull varying as the product of their masses and inversely as the square of the distance between them.

The connection between force, mass, and acceleration can be experimentally observed by Atwood's machine, which has already been partially illustrated (*see* Fig. 49, p. 31). It consists of a pulley, mounted in as frictionless a manner as possible, and bearing a cord to the two ends of which two equal weights A and B are fastened. An additional small weight P, in the form of a long thin plate, is added to one of the equal weights, which, when let go, move with a uniformly accelerated motion, till at a certain point in its fall the little weight P is lifted off in passing through a ring; A and B now moving on with a uniform *velocity*. This arrangement enables the *acceleration* of a given mass, that of A + B + P, due to a given force, P, to be measured.

By varying, first the force, and then the mass, it is found that (1) acceleration is proportional to force when mass is constant; (2) acceleration is inversely proportional to mass when the force is constant; and hence acceleration is proportional to $\frac{\text{force}}{\text{mass}}$.

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* This is not so self-evident as it at first sight appears to br. It is, however, usually assumed to be true.

We have now only to choose such units as shall make this proportion simple equality.

There are three systems of units, any one of which will do this.

In the C.G.S. (centimetre, gramme, second) system the unit of length is one metre—about 39·37 inches—the unit of mass is one gramme, which represents the mass of one cubic centimetre of distilled water at the temperature of 4° C., and the unit of force is one *dyne*, or that force which *acting on one gramme for one second generates a velocity of one centimetre per second.*

This system is very scientifically arranged as regards the connection between its various units, and the decimal system being employed, such operations as multiplication or division are rendered extremely easy. It has the great practical disadvantage that its units of force and mass are inconveniently small, and hence ordinary forces with which practical men have to deal require to be expressed by very large numbers.

In the British Absolute System the unit of length is one foot, the unit of mass is one pound, and the unit of force is *one poundal*, or that force which acting on one pound for one second generates a velocity of one foot per second. In this system the unit of force is about $\frac{1}{32}$ of the force with which the earth attracts one pound-weight, and however excellent and scientific the system may be, practical men find the unit of force a little too small; however, it may in time be generally adopted.

In the *British Gravitation* or *Engineer's* system the *force due to the weight of one pound* is taken as the unit of force, but as it varies a little at different localities and levels it is usual now in the best books to find this unit defined as the force with which the earth attracts a pound-weight *at the sea-level at Greenwich.* The unit of mass will then be the mass of about 32·2 pounds; the unit of length being, as before, one foot or $\frac{1}{3}$ of the standard yard, which is the distance between the centres of two gold plugs in a platinum bar kept at the Standards Office of the Board of Trade at Westminster. In any of these systems the law, acceleration $= \frac{\text{force}}{\text{mass}}$, or force = mass × acceleration, is true.

The last mentioned system is that adopted by most practical engineers, and we shall use it throughout these lessons. For convenience we shall use such expressions as "a force of 10 pounds," meaning a force equal to the weight of 10 pounds. The mass of any body is, in this system, obtained by *dividing its weight in pounds by* 32·2. The student will best understand the rules already given by working the following exercises.

EXAMPLES.

1. A boy drops a stone down the shaft of a mine and finds that it takes 3·5 seconds to reach the bottom: what is the depth of the shaft?

Here the rule is

$$h = \tfrac{1}{2}gt^2,$$

in this case

$$\begin{aligned} h &= \tfrac{1}{2} \times 32{\cdot}2 \times 3{\cdot}5^2 \\ &= 16{\cdot}1 \times 12{\cdot}25 \\ &= 197{\cdot}2 \text{ feet.} \end{aligned}$$

2. Find the velocity of the stone just before it touched the bottom of the shaft, and also its velocity when it had fallen 100 feet.

The rule for the first part of the question is

$$\begin{aligned} v &= gt \\ &= 32{\cdot}2 \times 3{\cdot}5 = 112{\cdot}7 \text{ feet per second.} \end{aligned}$$

The second part is solved by the rule

$$\begin{aligned} v^2 &= 2gh \\ &= 64{\cdot}4 \times 100 \\ \text{or} \quad v &= \sqrt{64{\cdot}4 \times 100} = 80{\cdot}25 \text{ feet per second.} \end{aligned}$$

3. A stone is projected vertically upwards with a velocity of 50 feet per second: how high will it rise?

Evidently, if we knew the height to which it will rise and dropped it from that height, its velocity would be 50 feet per second when it reached us. In other words, from what height must the body fall to acquire a velocity of 50 feet per second? As before, the rule is

$$v^2 = 2gh,$$

whence

$$h = \frac{2500}{64{\cdot}4} = 38{\cdot}8 \text{ feet}$$

4. A man descends a mine 4000 feet deep with a uniform velocity. Having descended for 4 minutes, he drops a stone, which reaches the bottom in 10 seconds. Find the velocity with which the man descends.

Let the man's velocity be v feet per second.

In 4 minutes he descends $v \times 240$ feet. The stone will have a velocity v to start with, and the distance it falls is $4000 - 240v$ feet.

The rule is

$$\begin{aligned} \text{distance } s &= ut + \tfrac{1}{2}gt^2, \\ \text{or } 4000 - 240v &= v \times 10 + 16{\cdot}1 \times 10^2; \\ \text{i.e., } 4000 - 1610 &= (240 + 10)v, \\ \text{or } v &= 9{\cdot}56 \text{ feet per second, the man's velocity required.'} \end{aligned}$$

5. What is the acceleration produced by a force of 10 lb. acting on a mass which weighs 100 lb.?

Answer, 3·22 feet per second per second.

6. If a locomotive move a train which, including engine, weighs 100 tons, giving to it a uniformly accelerated motion such that in 10 minutes after

starting it has a velocity of 20 miles an hour, find the weight of a second train which the same engine draws, and which gets up a speed of 7 miles an hour in 5 minutes; the total resistance and the pull of the locomotive being taken as the same in both cases.

Let F be the *effective* pull of the locomotive in both cases, W the weight of the second train in tons, and for convenience let accelerations be expressed in miles per hour per minute; then it is easy to see that, since force = mass × acceleration,

$$\frac{F}{F} = \frac{2 \times 100}{\frac{7}{5} \times W}, \text{ from which } W = 143 \text{ tons nearly.}$$

7. In Atwood's machine equal weights of ¾ lb. are suspended by the string passing over the pulley, and a bar weighing $\frac{1}{16}$ lb. is laid across one of them. This bar, after falling 2 feet, is lifted off. How far will the remaining masses move in the next 10 seconds? Answer, 72 feet.

8. A man weighing 160 lb. descends the shaft of a mine with an acceleration of 2 feet per second per second: find the pressure he exerts on the floor of the cage. Answer, 150·1 lb

9. A ball is laid on a *smooth* inclined plane, the inclination of which is 1 in 20· find the acceleration of the ball, and the distance it will go in 3 seconds.

Since acceleration $\propto$ force, and the force down a smooth plane is weight $\propto \times \frac{\text{height of plane}}{\text{length}}$, the acceleration down the plane is $g \times \frac{\text{height}}{\text{length}}$.

Answers, 1·61 feet per sec. per sec.; 7·245 feet.

MOMENTUM—NEWTON'S LAWS OF MOTION.

It may be well at this stage to state Newton's laws of motion, which were the first concise statement of the axioms of dynamics. In substance they are as follows:—

First Law.—A body preserves its state of rest or uniform motion in a straight line unless acted on by external forces.

Second Law.—Change of motion is proportional to the impressed force, and takes place in the direction in which that force acts.

Third Law.—To every action there is an equal and opposite reaction, or action and reaction are equal and opposite.

The first law gives us a definition of force. The second law introduces us to a matter of great importance. We have seen that if a force act on a body free to move, the resulting motion will be governed by the law—

$$\text{force} = \text{mass} \times \text{acceleration},$$

or, in algebraic form, $F = m \times a$. Going back to the beginning of the present lesson you will remember we had the elementary law $v = u + a t$, the + sign being replaced by a − if the velocity *decreases*.

Taking these two rules together we have

$$F = a \times m,$$
$$\text{and } v = u + at.$$

From the last

$$a = \frac{v - u}{t};$$

hence the first becomes

$$F = \left(\frac{v - u}{t}\right) m, \quad \text{or} \quad Ft = vm - um,$$

the same double meaning being attached to the sign on the right-hand side as before.

The product of the mass and velocity of a body is called its *momentum;* it was formerly called "quantity of motion," and hence the law just obtained agrees with Newton's second law of motion

We see, then, that if an unbalanced force act for a given time on a body free to move under the action of that force, the product of the force and time will be equal to the *change of momentum* produced, or the force will be equal to the *change of momentum produced divided by the time in which that change is produced.* From this it follows that a force is correctly estimated by the *change of momentum produced per second.*

If the initial velocity, u, be zero—that is, if the body begins to move under the action of the force—then the law is

$$Ft = mv,$$

the momentum $m v$ being produced by the force F in the time t; and the same rule holds if the momentum be destroyed.

If the time t is too short to be measured, the force's "impulse" is measured by the momentum produced or destroyed.

A few examples will bring home to the student the practical bearing of these rules.

NUMERICAL EXAMPLES.

1. How long will a mass weighing 150 lb., and moving with a velocity of 20 feet per second, move against an opposing force of 10 lb.?

Let t be the required time,

$$\text{then } Ft = mv,$$
$$10 \times t = \frac{150}{32 \cdot 2} \times 20,$$
$$\text{or } t = 9 \cdot 3 \text{ seconds.}$$

2. A train weighing 100 tons, moving at the rate of 30 miles an hour, is brought to rest in 2¼ minutes: find the average resultant force acting against the train's motion. Answer, 2281·5 lb.

3. A body weighing 20 lb. falls freely through a

height of 200 feet: find the average force required to stop it in the next 5 seconds.

The velocity of the body is obtained by the rule

$$v^2 = 2gh,$$

$$\text{hence } v = \sqrt{64{\cdot}4 \times 200} = \sqrt{12880} = 118{\cdot}49 \text{ feet per second.}$$

The momentum of the body after falling the 200 feet is

$$\frac{20}{32{\cdot}2} \times 118{\cdot}49 = 70{\cdot}47;$$

hence the average force required, if the body moved horizontally, would be

$$\frac{70{\cdot}47}{5} = 14{\cdot}094 \text{ lb.}$$

But it takes 20 lb. to merely balance the body's weight, hence the required force is

$$20 + 14{\cdot}09 = 34{\cdot}09 \text{ lb.}$$

4. A pile-driver weighing 300 lb. falls through a height of 20 feet, and is stopped in $\frac{1}{5}$th of a second find the average force it exerts on the pile.

Answer, 1672·5 lb.

5. A ball weighing 8 lb., and moving with a velocity of 50 feet per second, receives a blow in a direction at right angles to its line of motion, and it then proceeds in a direction making an angle of 45° with the direction of its former path: find the "impulse" imparted by the blow. Answer, 12½

KINETIC ENERGY—TRANSFORMATION OF ENERGY—PRACTICAL ILLUSTRATIONS AND EXAMPLES

That a body having mass—scientists being unacquainted with bodies which have not—and moving with any given velocity, *has* energy by virtue of its motion is easily demonstrated. A projectile can do work by indenting or entering the substance of a target, a moving train can do work grinding the brakes when being stopped, and the fly-wheel of a steam-engine can move the whole engine after the steam is shut off by reason of the store of kinetic energy it possesses. We have already explained the way in which the *potential* energy of a raised weight can be estimated, and the reader will readily see that in very many cases it is easy to transform potential energy into this energy of motion or *kinetic* energy to which we are now referring For instance, if a weight of W lb. is at a height of h feet, it possesses W h foot-pounds of potential energy, or energy due to its *position*.

If this weight is let fall freely, it will in falling through h feet acquire a velocity which is obtained from the rule $v^2 = 2gh$.

But it has lost W h foot-pounds of potential energy, and since energy is indestructible it must have *gained* W h foot-pounds of energy in some other form or forms.

Since it falls freely, the only kind of energy developed is the kinetic energy of the weight itself, which must, therefore, be W h foot-pounds in amount. To express this in terms of the velocity imparted to the weight, for h substitute its value $\frac{v^2}{2g}$, and the kinetic energy of the moving body is W $\times \frac{v^2}{2g} = \frac{1}{2}mv^2$, where m is the mass of the moving weight. The kinetic energy of a moving body expressed in foot-pounds is equal to the *product of half its mass and the square of its velocity*, the velocity being measured in feet per second. We have here taken up only a particular case of the general problem, for the body may move in *any* direction. Suppose a body of mass m to move a distance of s feet in any direction under the action of a constant force F, then the work done on the body—moving with a uniformly accelerated motion—is F $\times s$. Let v_1 be its velocity at the beginning, and v_2 its velocity at the end of the interval of time considered. Then, since distance = average velocity × time, $s = \frac{(v_2 + v_1)}{2} . t$, and from what has been already stated in regard to the value of a force in connection with change of momentum, we have

$$\text{F} = m\frac{(v_2 - v_1)}{t},$$

$$\text{hence}\quad \text{F} \times s = m\frac{(v_2 - v_1)}{t} \times \frac{(v_2 + v_1)}{2} . t$$

$$= \frac{m}{2}(v_2^2 - v_1^2) = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2,$$

or the *work done is equal to the change of kinetic energy*. If the force is of the nature of a resistance and *opposes* the body's motion, the rule is still true, only v_1 will then be greater than v_2, *negative* work being done on the body. Many instances could be given in which there is a continual interchange going on between the two kinds of energy, their *sum*, however, always remaining the same. Thus a pendulum, if we neglect the small resistance to its motion due to friction, has at the ends of its swing its energy in the form of a potential store; at the centre or lowest point of its path the energy has taken the kinetic form; and at any other point its store is partly kinetic and partly potential, the sum of the two amounting to the same number of foot-pounds as in any of the other two cases A switchback railway is another good illustration of the same thing, and if we neglect all resistances, the carriage will always have the same total store of energy; when at points on the same level it will have the same *potential* store, and hence should be moving with the same velocity. Other instances in which a similar thing occurs will suggest themselves to the reader.

The various phases of this very important subject will best be brought out in a few examples.

Examples.

1. A shot weighing 12 lb. leaves the mouth of a gun with a velocity of 1000 feet per second: find its kinetic energy and the mean resistance offered by an obstacle into which it penetrates a distance of 2 feet.

$$\text{Kinetic energy} = \tfrac{1}{2}\,\text{mass} \times (\text{velocity})^2$$
$$= \frac{1}{2} \times \frac{12}{32{\cdot}2} \times 1000^2 = 186{,}335 \text{ ft.-lb.}$$

Let F be the average resisting force; then—

$$186{,}335 = F \times 2, \text{ or } F = 93{,}167\tfrac{1}{2} \text{ lb.}$$

2. A railway waggon weighing 10 tons is drawn from rest by a horse; after going 300 feet it is moving at the rate of 5 feet per second: if the tractive resistances amount to 8 lb. per ton, find the amount of work done by the horse.

The work done consists of two parts—first, that done in overcoming resistance; and, second, that done in giving kinetic energy to the waggon.

The first, since the total resistance is 10 × 8 lb., amounts to 80 × 300, or 24,000 ft.-lb.; the second is

$$\tfrac{1}{2}\frac{10 \times 2240}{32{\cdot}2} \times 5^2 = 8695{\cdot}6 \text{ ft.-lb.}$$

Hence the total work done is—

$$24{,}000 + 8695{\cdot}6 = 32{,}695{\cdot}6 \text{ ft.-lb.}$$

3. A projectile leaves the mouth of a gun with a velocity of 1000 feet per second: find its velocity when it is at a height of 100 feet above the level of the gun, neglecting atmospheric friction.

The total store of energy the projectile possesses is in the kinetic form just as it leaves the gun, and amounts to $\frac{1}{2}\frac{W}{32{\cdot}2} \times 1000^2$ ft.-lb., where W is the weight of the projectile in pounds.

At the higher point the energy is partly kinetic and partly potential (the latter being $= W \times 100$ ft.-lb.), but the sum of the two amounts is the same total store as before. Let v feet per second be the velocity at the higher point, then

$$\tfrac{1}{2}\frac{W}{32{\cdot}2} \times 1000^2 = W \times 100 + \tfrac{1}{2}\frac{W}{32{\cdot}2} \times v^2.$$

We may discard W all across, showing that the weight of the projectile does not enter into the question; and our equation simplified stands thus:—

$$1000^2 = 100 \times 64{\cdot}4 + v^2.$$

Or,

$$1{,}000{,}000 - 6440 = v^2.$$
$$993{,}560 = v^2.$$

Or,

$$v = \sqrt{993{,}560} = 996{\cdot}77 \text{ feet per second.}$$

4. Find the work done by a winding engine which raises a cage weighing 6 tons from a pit 400 yards deep, and gives to the cage a velocity of 24 feet per second at the top of the shaft. If this work is done in 6 minutes, find the horse-power actually applied. Ans., 16,248,960 ft.-lb.; 82·06 h.p.

5. If the weights in Atwood's machine are 3 and 2 lb., find the work done by gravity whilst the heavier falls 10 feet. Ans., 10 ft.-lb.

MINERALOGY.—II.

[Continued from p. 166.]

CRYSTALS AND CRYSTALLOGRAPHY.

The name Crystal (Greek κρύσταλλος, *krustallos*, clear ice) was given by the ancients to the transparent and colourless variety of quartz (SiO_2), that we still term rock-crystal, which they believed to have been formed from water by intense cold. They observed that it occurred in a definite form bounded by flat surfaces (or planes), six of which formed a column or prism, whilst at one end or at both ends of this prism is a six-sided pyramid (Fig. 7). The term crystal was afterwards extended to other minerals, even when coloured or opaque, when enclosed by plane surfaces, these surfaces being almost as characteristic of the mineral kingdom as curved outlines are of plants and animals.

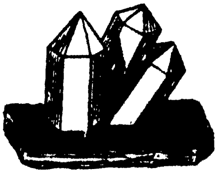

Fig. 7.—Rock-Crystal.

The relative sizes and shapes of the surfaces or *faces* of rock-crystal or other minerals vary in different specimens; but it was pointed out in 1669 by Steno, a Danish physician, that the angles between the faces, *i.e.*, their mutual inclinations, were constant. At the same time it was recognised that one mineral substance may crystallise in a variety of forms, though not till 1772 was it shown by Romé de l'Isle that the various forms of each species or kind of mineral are geometrically related to one another; that one can be obtained from another by a symmetrical replacement or truncation of its angles by certain planes; and, in fact, that the various forms are all arranged on the same type.

The next step in the advance of our knowledge of crystals was partly the result of accident. A six-sided prism of the mineral calcite ($CaCO_3$) fell from the table of M. l'Abbé Haüy (1784) and broke with a smooth plane fracture. Haüy then found that with a knife or needle further slices could be split off parallel to this new face, and also in other directions similarly related to the alternate edges of the prism, until the six-sided prism was reduced to a rhombohedron or form enclosed by six rhombs (Fig. 8). Haüy discovered that other forms of calcite could be similarly reduced to the rhombohedron; that most crystals can be thus split or *cleaved* in certain directions more readily than in others; and that those of each species can be thus reduced to some one *fundamental form*. Thus galena (PbS), the chief ore of lead, commonly crystallises in cubes or in such forms as **Fig. 8**, in which the solid angles of the cube are truncated by the faces of the octahedron; and this mineral cleaves most readily parallel to the faces of the cube. The cleavage-planes of any mineral are, in fact, either parallel to some of the faces of the crystal, or make fixed angles with them, being, that is, parallel to the faces of some other form of the same type or *system*. We now know that the reason for this *cleavage* is that the molecules or ultimate particles of the mineral do not cohere so firmly in directions at right angles to the cleavage-planes as they do in other directions.

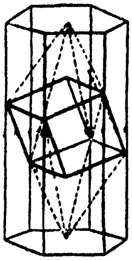

Fig. 8.—Diagram showing how the Rhombohedron can be obtained from the Six-sided Prism.

This is only one aspect of that law of symmetry which is one of the principles of creation. It is observable in every organic construction that about a certain plane or planes the body is similarly built up. For instance, a plane which passes through the centre of the human frame would divide the body into two similar halves. So with crystals, they are all arranged symmetrically about certain lines known as *axes*. "In whatever manner, or under whatever circumstances a crystal may have been formed, whether in the laboratory of the chemist or in the workshop of nature, in the bodies of animals or in the tissues of plants, up in the sky or in the depths of the earth, whether so rapidly that we may literally see its growth, or by the slow aggregation of its molecules during perhaps hundreds, perhaps thousands of years, we always find that the arrangement of the faces of the crystal" is "subject to fixed and definite laws." *

Nor is this all; for, as we have already seen to some extent in our previous lesson, all the other physical properties of a crystal as well as its form depend upon the same law. Its conduction of heat, magnetism, or electricity, and especially its transmission of light in various directions, are closely connected with its form; and it was the investigation of the optical characters of minerals, especially their action on polarised light, by Sir David Brewster between 1819 and 1833 that established the fact that all crystalline forms can be referred to six geometrical systems. As, when we study the derivation of forms from a fundamental one by replacement or truncation of its edges or angles, we find that all similar parts are similarly modified, we may state one of the fundamental laws of the science of crystallography still more generally by saying that all similar directions in a crystal are similarly endowed. "This law, it must be remembered," says Mr. Gurney, "has not been arrived at by abstract reasoning. It is only the expression in words of the results of observation of crystals. It is no mere creation of the human brain, it is the utterance of crystals themselves to those who have ears to hear, it is written in them in characters that can be clearly read by eyes that will take the trouble to look for it."

A *crystal* may then be defined as a solid bounded by plane surfaces or *faces* and generally exhibiting a tendency to split in directions, known as *cleavage-planes*, either parallel to some face or at fixed angles with the faces. Diamond is one of the few exceptional cases of minerals with curved instead of plane faces. The line where two faces intersect is an *edge*: the angle thus formed is a *plane angle*; and the angle of a corner—that is, an angle formed by three or more faces meeting in a point—is a *solid angle*.

Just as the position of any spot on the surface of the globe can be fixed by its reference to two lines, one of latitude, the other of longitude, so the position of the faces of crystals is described by reference to three lines known as *crystallographic axes*. These lines may be of any length; but they must intersect at a point within the crystal, be parallel to some three edges of the crystal, and not be all in one plane. The point at which they intersect is termed the *origin*, and the distance (measured along the axis) between this point and that at which a face cuts the axis is termed the *intercept* of that face along that axis. A face may be parallel to one axis or to two axes; but every plane in the universe must cut at least one of these indefinitely prolonged axes.

In each of the six crystallographic systems, some one plane is taken as a plane of reference, and is known as the *parametral plane*. It is one cutting all the three axes at intercepts having a constant ratio in each system, and the simplest whole numbers expressing these ratios are called the *parameters*. The inclination of any face of a crystal to its axes may then be expressed by a *symbol*, consisting of three *indices*, showing what fraction of each parametral intercept is intercepted between the face and the origin. Thus in Fig 9, O is the origin, $X O \bar{X}$, $Y O \bar{Y}$, $Z O \bar{Z}$ the axes, and A B C the parametral plane. Then the ratios of the intercepts O A, O B, and O C are expressed by numbers representing the parameters, *a*, *b*, *c*. If the intercepts be equal, as in the Cubic and Hexagonal systems, the parameters are 1 1 1. If a face cut the axes, as at H K L, it will be represented by indices *hkl*, which will be whole numbers such that the intercept $O H : O K : O L = \frac{a}{h} : \frac{b}{k} : \frac{c}{l}$.

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* See "Crystallography," by the Rev. H P. Gurney.

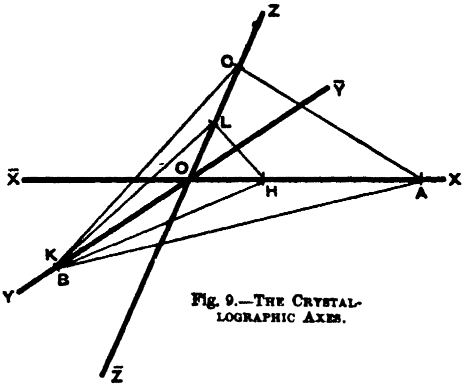

Fig. 9.—The Crystallographic Axes.

When a plane is parallel to one or two axes the index corresponding to such axis is zero. Thus the six faces of a cube are 1 0 0, 1 0 0, 0 1 0, 0 $\bar{1}$ 0, 0 0 1, and 0 0 $\bar{1}$, each face cutting one axis, and being parallel to the other two. If a face cut an axis produced on the other or negative side of the origin, the index for that axis is *barred*, *i.e.*, has the negative sign written over it, as in the second, fourth, and sixth of the faces just enumerated. As the indices are usually taken for the axes O X, O Y, O Z in this order, the face 1 0 0 is one "end" of the cube; $\bar{1}$ 0 0 the opposite end; 0 1 0 the front; 0 $\bar{1}$ 0 the back; 0 0 1 the top; 0 0 $\bar{1}$ the bottom; the barred symbol being always parallel to the same symbol unbarred.

Similarly, as mere linear dimensions, the distance of any actual face of a crystal from the origin, or its consequent size, are in nature subject to no law, the same symbol will represent any number of parallel planes provided they are on the same side of the origin. Crystals are therefore seldom geometrically regular forms like the artificial models commonly made to explain them. Though perfectly regular dodecahedra of garnet, octahedra of magnetite or diamond, and cubes of fluor, galena, or pyrite may occur, it is at least as commonly the case in the latter mineral, for instance, that the cube is represented by a solid that geometry would rather term a right square prism. There are, in fact, many cases in which practically identical forms occur in two crystallographic systems, and in which we depend mainly upon optical characters to determine to which system the mineral occurring in them truly belongs.

Whilst a face is represented simply by a symbol of three indices, a simple crystalline form is represented by the symbol of its face which has the simplest symbol, enclosed in brackets. Thus the cube is $\{100\}$, which is read "the form 1, 0, 0," and implies that it has the face *1 0 0* and all the other faces which necessarily coexist with that face.

If in our figure the intercepts OA, OB, OC be respectively $1\frac{1}{2}$ inch, 1 inch, and $\frac{3}{4}$ inch, the parameters will be 6,4,3. Then if, for example, OH $= \frac{1}{2}$ inch, OK $= 1$ inch, and OL $= \frac{3}{8}$ inch, they are in the ratio 4 : 8 : 3. Then $4 : 8 : 3 = \frac{6}{h} : \frac{4}{k} : \frac{3}{l}$. Therefore, *h*, *k*, *l* are 3, 1, 2, since $\frac{6}{3} : \frac{4}{1} : \frac{3}{2} = 2 : 4 : \frac{3}{2} = 4 : 8 : 3$.

The inclination of the faces of a crystal to its axes is determined indirectly by the measurement of that of two adjacent faces to one another, of the angles of the edges, or plane angles, that is to say. The instruments by which this is accomplished are known as *goniometers* (Greek *γωνία*, *gōnia*, an angle; *μέτρον*, *mĕtrŏn*, a measure). The simplest form of goniometer is that known as the *contact goniometer*, originally made for Romé de l'Isle, by Carangeot, and consisting merely of a graduated semicircle with a movable arm. The edge to be measured is placed between the movable arm and the base of the semicircle.

An instrument capable of being used with smaller crystals and yielding more precise results is the reflective goniometer invented by Wollaston. This consists essentially of a graduated circle with a vernier and an axis with universal-jointed arm capable of being turned independently of the circle. The crystal is cemented to the arm and turned until the edge to be measured is parallel with the axis of the instrument. The reflection of some "signal," such as an illuminated slit or a window bar, is then observed in one of the faces forming the edge, and the instrument is turned until this signal is reflected in the other face. The angle through which it is then found to have been turned is the inclination of the two faces.

The law which we have mentioned, that all similar directions in a crystal are similarly endowed, is subject to an important series of exceptions. For example, the regular octahedron (Fig. 10), an eight-sided figure with a square base or plane of junction between two pyramids placed base to base, and each having four equilateral triangles as sides, is $\{111\}$ of the Cubic system, being a common form of the minerals magnetite, diamond, and gold. Its eight faces are the parametral plane $1\,1\,1$ and $\bar{1}\,\bar{1}\,\bar{1}$, $1\,1\,\bar{1}$, $\bar{1}\,\bar{1}\,1$, $1\,\bar{1}\,1$, $\bar{1}\,1\,\bar{1}$, $1\,\bar{1}\,\bar{1}$ and $\bar{1}\,1\,1$. In some crystals, however, only half these faces are present,

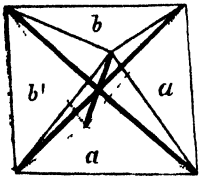

Fig. 10.—THE REGULAR OCTAHEDRON.

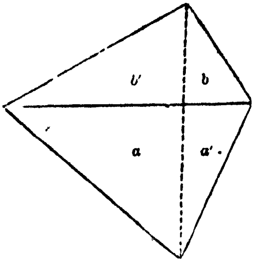

Fig. 11.—THE TETRAHEDRON.

giving us the form known as the *tetrahedron* (Fig. 11), enclosed by four triangles, either $1\,1\,1$, $1\,\bar{1}\,\bar{1}$, $\bar{1}\,1\,\bar{1}$ and $\bar{1}\,\bar{1}\,1$, or $\bar{1}\,\bar{1}\,\bar{1}$, $\bar{1}\,1\,1$, $1\,\bar{1}\,1$ and $1\,1\,\bar{1}$ Forms, such as the regular octahedron, in which all the faces required by the law of symmetry co-exist, are termed *holohedral* (Greek ὅλος, *hŏlŏs*, the whole), whilst those, such as the two tetrahedra just mentioned, in which only half these faces occur, are called *hemihedral* (Greek ἡμι, *hēmi*, half; ἕδρα, *hĕdra*, a base). As they neither of them have any two faces parallel to one another these forms are said to be hemihedral with inclined faces, and are represented by the symbols $\kappa\left\{1\,1\,1\right\}$ and $\kappa\left\{\bar{1}\,\bar{1}\,1\right\}$ The mineral galena, as we have seen, often crystallises in the form of a cube with its eight solid angles replaced by the faces of the octahedron, or, as it is termed, in a combination of $\left\{1\,0\,0\right\}$ with $\left\{1\,1\,1\right\}$; but boracite, which we mentioned in our last lesson as being pyro-electric, crystallises in combinations of $\left\{1\,0\,0\right\}$ with $\kappa\left\{1\,1\,1\right\}$, that is, it only has its four alternate solid angles replaced. *Tetartohedral* forms, or forms having only one-fourth of the faces required by the law of symmetry, also occur.

The crystallographic axes are by no means purely imaginary lines, for they represent directions along which the mysterious force of molecular aggregation known as crystallisation has acted.

In addition to the three crystallographic axes many crystals have other axes known as *axes of symmetry*. These are the lines of intersection of two or more *planes of symmetry*, or planes by which the crystal can be divided into two absolutely symmetrical halves. Some crystals cannot be symmetrically divided by any plane. These are termed *anorthic* or *triclinic* (Greek ἀ-, *a*-, not; ὀρθός, *ŏrthŏs*, straight; τρι-, *tri*-, thrice; κλίνω, *klinō*, I bend), because they will not stand erect in any position. Others have only one plane of symmetry, and consequently no symmetrical axis. These are termed *oblique* or *monoclinic* (Greek, μόνος, *mŏnŏs*, one; κλίνω, *klinō*, I bend), as they stand in an inclined position on one of three pairs of parallel faces. Other forms have three, five, seven, or nine planes of symmetry. In these forms the axis in which the greatest number of planes of symmetry intersect is called the *morphological axis* or axis of form (Greek μορφή, *mŏrphē*, form).

The grouping of crystals into *systems* depends upon the inclination of the three axes, the relative length of the parameters, and the number of planes of symmetry, geometrical characters which, as we have seen, correspond closely with optical and other important physical characters.

There are six systems of crystals. The name mentioned first in the following table is that which we shall use, though the other italicised names are in common use —

1 *Anorthic*, *triclinic*, diclinic, doubly oblique.
2. *Oblique*, *monoclinic*.
3. *Prismatic*, *rhombic*, trimetric, right rectangular.
4. *Pyramidal*, *tetragonal*, dimetric, right square prismatic
5 *Hexagonal*, *rhombohedral*.
6. *Cubic*, monometric, regular, tesseral, octahedral

The *anorthic system* has its three axes inclined at unequal angles to one another, none of them being a right angle; its parameters all unequal; no plane of symmetry; two optic axes giving four dissimilar segments in the "figures of eight" with polarised light; and unequal conductivity for heat and expansion under its influence in three directions perpendicular to one another. No simple form in this system can consist of more than two faces; so, since two planes cannot enclose a solid, all anorthic crystals must be combinations of two or more forms. The most common of these combinations is the *doubly oblique*, or *oblique rhomboidal*, *prism* (Fig. 12). Blue vitriol (hydrous copper sulphate, or chalcanthite, $CuSO_4 + 5H_2O$), more common in the arts than in nature, crystallises in this system, as do also several of the felspar group, such as labradorite and anorthite.

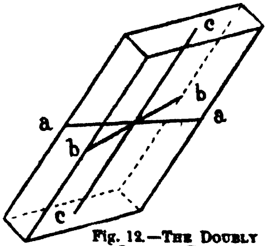

Fig. 12.—THE DOUBLY OBLIQUE PRISM.

The *oblique system* has two of its axes at right angles to one another; all its parameters unequal; one plane of symmetry; two optic axes giving two dissimilar pairs of segments in the "figures of eight"; and unequal conductivity for heat and expansion in three perpendicular directions. A simple form in this system may have four faces; but every actual crystal belonging to it is a combination of more than one form. Among the more simple of these are the ***oblique prism*** (Fig. 13) and the ***oblique octahedron*** (Fig. 14). Many minerals crystallise in this system, including selenite, the crystalline form of gypsum ($CaSO_4 + 2H_2O$), green vitriol or melanterite, hydrous iron sulphate ($FeSO_4 + 7H_2O$), orthoclase felspar, augite, and hornblende, not to mention sugar-candy.

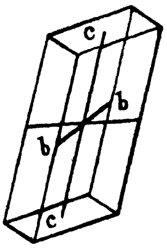

Fig. 13.—The Oblique Prism.

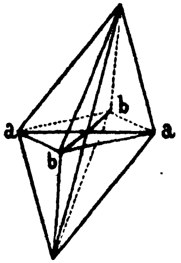

Fig. 14.—The Oblique Octahedron.

The *prismatic system* has its axes all at right angles, but its parameters unequal; three planes of symmetry; two optic axes giving symmetrical "figures of eight"; but a conductivity and expansion for heat unequal in three perpendicular directions. Several prismatic forms belonging to this system have a rhombic base, as has also the octahedron with scalene sides,* the form $\{111\}$, in which native sulphur commonly crystallises. Hence, the system is often called Rhombic. Fig. 15 is the *right* (*i.e.*, upright) rectangular prism. Besides sulphur, nitre (KNO_3), aragonite (one form of calcium carbonate, $CaCO_3$), topaz, baryte ($BaSO_4$), and nearly all other anhydrous sulphates crystallise in this system.

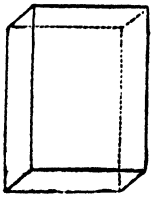

Fig. 15.—Right Rectangular Prism.

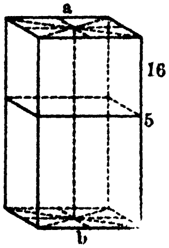

Fig. 16.

The ***pyramidal system*** is much less frequent in nature. In it the axes are all at right angles, and two parameters are equal. There are five planes of symmetry, four of which intersect in the same straight line (the "morphological axis" *a b* in Fig. 16), making angles of 45° with each other; whilst the fifth (5 in Fig. 16) is perpendicular to them. There is only one optic axis—that known also as the morphological axis; so that sections of crystals cut at right angles to this axis (parallel, that is, to the fifth plane of symmetry in Fig. 16)—which will generally be four or eight-sided, if not absolutely square—present concentric rings of colour traversed by an equal-armed cross, or double-brush, when examined by polarised light. Crystals in this system conduct heat and expand under its influence at a different rate in the direction of the morphological axis from that in any other direction. The form $\{001\}$ in this system consists of two parallel faces, whilst $\{100\}$ and $\{110\}$ each consist of the four sides of a square prism. The combination of $\{001\}$ with either $\{100\}$ or $\{110\}$ is called a ***right square prism*** (Fig. 16): that of all three forms is an eight-sided prism. The sides of another eight-sided prism constitute a simple form $\{hk0\}$, which in combination with the three just mentioned gives us a sixteen-sided prism. Other simple forms are the ***square-based octahedra*** (Fig. 17), and the ***double eight-faced pyramid***, a sixteen-sided figure with two solid angles, each formed by the meeting of eight faces. Cassiterite, the oxide and commonest ore of tin (SnO_2), is the best known mineral crystallising in the pyramidal system. It commonly occurs in combinations of right square prisms with square octahedra (Figs. 18 and 19).

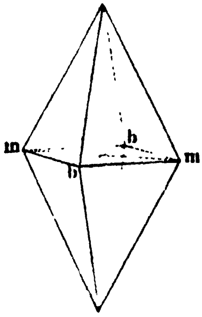

Fig. 17.—Square-based Octahedron.

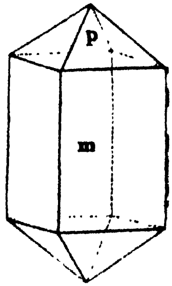

Fig. 18.—Crystal of Cassiterite.

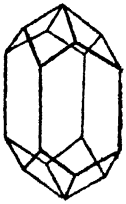

Fig. 19. Another Form of Cassiterite.

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* *N.B.*—The "base" of an octahedron is the plane in which the two four-sided pyramids unite.

ITALIAN.—X.

[*Continued from p. 158.*]

REGULAR VERBS (*continued*).

I. Remarks on the Indefinite Mood.

1. The third conjugation comprehends, strictly speaking, three classes, of which only the first coincides in all the details with *sentire*. They will be explained later.

2. The present participle, like the adjectives ending in *e*, is of both genders, and in the plural ends in *i*.

3. Gerunds are liable to no irregularities, and are indeclinable.

II. Remarks on the Indicative Mood.

1. In the second and third conjugations the letter *v* may be omitted in the third person plural as well as in the singular, and *te-mé-a-no*, *cre-dé-a-no*, *sen-ti-a-no*, *dor-mi-a-no*, may be used for *te-mé-va-no*, *cre-dé-va-no*, *sen-ti-ra-no*, *dor-mi-va-no*, etc.

2. It is evident that the terminations *-i*, *-sti*, *-mmo*, *-ste*, and *-rono*, in this tense, are common to all conjugations, while their difference only consists in the characteristic letter preceding those terminations, viz., *a* in the first, *e* in the second, and *i* in the third conjugation.

3. Several, not all, verbs of the second conjugation have a double termination of this tense in *-ei* and *-etti* in the first and third person singular, and in the third person plural.

PASSIVE VERBS.

The Italian language, like the English, has no special terminations to express the passive voice, which is formed, as in English, by means of the auxiliary verb *essere*, to be. It is on this account sufficient to know this verb and the past participle of the principal verb, since the combination of these two through all tenses forms the passive voice, as, *amo*, I love; *sono amato*, I am loved; *temo*, I fear; *sono temuto*, I am feared; and thus through all the tenses of *essere*. The verb *ve-ní-re*, to come, may also be used instead of *essere*, with a passive verb, but only in its simple, and never in its compound tenses, as, *vên-go a-má-to*, I am loved, instead of *sono amato*. In addition to *venire*, occasionally the verbs *re-sta-re* (to remain, be left), *ri-ma-né-re* (to remain), *an-dá-re* (to go), and *stá-re* (to stand) may be employed as auxiliaries to conjugate the simple tenses of the passive voice. That the use of *essere* and *venire* is not arbitrary—*essere* denoting that some act has been accomplished, while *venire* generally expresses that some act has commenced without being completed—may be seen in these two phrases: *il quá-dro è di-pín-to*, the picture is painted, and *il quá-dro viê-ne di-pín-to*, the picture is being painted.

The past participle, forming with the tenses and moods of *essere* the passive voice, must be considered as a real adjective agreeing with the passive subject or nominative in gender and number. This rule is invariable, even when the verbs *andare*, *restare*, *rimanere*, *stare*, and *venire* are used in the place of *essere*, for example:—

Nói (uô-mi-ni) siá-mo stá-ti in-gan-ná-ti, *we (men) have been deceived.*

Nói (dôn-ne) siá-mo stá-te in-gan-na-te, *we (women) have been deceived.*

Tá-li cô-se non ván-no fat-te co-sì, *such things are not done in this way.*

Tút-ti ri-má-se-ro ma-ra-vi-gliá-ti, *all were astonished.*

There is a peculiar way of expressing the passive voice by means of the pronoun *si*.

To change active verbs into passive the case-sign *da* or the preposition *per* must be put before the subjects of the active voice on which some act depends, or which are its authors or causes, for example, the following sentences:—

Sci-pió-ne di-strús-se Car-tá-gi-ne, *Scipio destroyed Carthage;*

An-ní-ba-le scon-fís-se più vól-te i Ro-má-ni, *Hannibal several times defeated the Romans,*

when changed into the passive will run as follows:—

Car-tá-gi-ne fu di-strút-ta da Sci-pio-ne, *Carthage was destroyed by Scipio*

I Ro-má-ni fu-ron più vól-te scon-fít-ti da An-ní-ba-le, *the Romans were several times defeated by Hannibal.*

Here is the model for the conjugation of passive verbs.

I. INDEFINITE MOOD.

Present.

Essere amato, *to be loved.*

Perfect.

Essere stato amato, *to have been loved.*

Present Gerund.

Essendo (io) amato, *being loved* (i.e., *because*, etc., *I*, etc., *am loved*).

Essendo (noi) amati, *being loved* (i.e., *because*, etc., *we*, etc., *are loved*).

Past Gerund.

Essendo (io) stato amato, *having been loved* (i.e., *because*, etc., *I have been loved*).

Essendo (noi) stati amati, *having been loved* (i.e., *because*, etc., *we*, etc., *have been loved*).

Past Participle.[1]

Stato amato, *having been loved.*

II. INDICATIVE MOOD.

Present.

Sing. Sono *or* vêugo am-ato, *I am loved.*
Sei *or* viêni am-ato.
È *or* viêne am-ato.
Plur. Siamo *or* veniámo am-ati
Siete *or* venite am-ati.
Sono *or* vêngono am-ati.

Imperfect.

Sing. Era *or* veniva am-ato, *I was loved.*
Eri *or* venívi am-ato.
Era *or* veniva am-ato.

Imperfect.

Plur. Eravamo *or* veniváme am-ati.
Eravate *or* veniváte am-ati.
Erano *or* venivano am-ati.

Indeterminate Preterite.

Sing. Fui *or* vênni am-ato, *I was loved.*
Fosti *or* venisti am-ato.
Fu *or* vênne am-ato.

Indeterminate Preterite.

Plur. Fummo *or* venimmo amati.
Foste *or* veniste am-ati.
Furono *or* vênnero amati.

Determinate Preterite.

Sing. Sono stato am-ato, etc , *I have been loved*
Plur. Siamo stati amati, etc.

Indeterminate Pluperfect.

Sing. Era stato am-ato, etc , *I had been loved.*

Determinate Pluperfect.

Sing. Fui stato am-ato, etc., *I had been loved.*

Future.

Sing. Sarò *or* verrò am-ato, *I shall be loved.*
Sarai *or* verrài am-ato
Sarà *or* verra am-ato.

Future.

Plur. Saremo *or* verrémo amati.
Sarete *or* verréte am-ati.
Saranno *or* verrànno amati.

Future Perfect.

Sing. Sarò stato am-ato, etc., *I shall have been loved.*

Conditional Present.

Sing. Sarei *or* verréi am-ato, *I should be loved.*
Saresti *or* verréati amato.
Sarebbe *or* verèbbe amato.
Plur. Saremmo *or* verrémmo am-ati.
Sareste *or* verréate amati.
Sarebbero *or* verrèbbero am-ati.

Conditional Past.

Sing. Sarei stato am-ato, etc., *I should have been loved.*

III. IMPERATIVE MOOD.

Sing. Sii *or* sia am-ato, *be thou loved.*
Sia am-ato.
Plur. Siamo am-ati
Siate am-ati.
Siano *or* sieno am-ati.

IV. SUBJUNCTIVE MOOD.

Present

Sing. Sia *or* vênga am-ato, *I may be loved.*
Sii (*or* sia) *or* vênga amato.
Sia *or* vênga am-ato
Plur Siamo *or* veniámo am-ati.
Siate *or* veniáte am-ati.
Siano *or* vêngano am-ati.

Perfect.

Sing. Sia stato am-ato, etc , *I may have been loved.*
Plur. Siamo stati am-ati, etc.

Imperfect.

Sing. Fossi *or* venissi am-ato, *I might be loved.*
Fossi *or* venissi am-ato.
Fosse *or* venisse am-ato.
Plur. Fossimo *or* venissimo am-ati.
Foste *or* veniate am-ati
Fossero *or* venissero amati.

Pluperfect.

Sing Fossi stato am-ato, etc.,

I. Remarks on the Indefinite Mood.

1. The Italian language has no *present* and *future* participles in the passive voice. Such words as *ve-ne-rán-do*, venerable, to be revered; *re-ve-rên-do*, reverend, venerable, and similar ones must be considered as adjectives. There is also no future participle in the active voice.

REFLECTIVE VERBS.

In these verbs the subject from which the action proceeds is at the same time a passive object, and for this reason is expressed *twice:* (1) by the personal pronoun *io*, I; *tu*, thou; *egli* or *esso*, he or it; *ella* or *essa*, she; *noi*, we; *voi*, you; *eglino*, *elleno*, or *essi*, *esse*, they; (2) by the so-called conjunctive pronouns *mi*, myself, or to myself (i.e., *a me*); *ti*, thyself, or to thyself (i.e., *a te*); *si*, himself, herself, itself, or to himself, etc. (i.e., *a se*); *ci*, ourselves, or to ourselves (i.e., *a noi*); *vi*, yourselves, or to yourselves (i.e., *a voi*); *si*, themselves, or to themselves (i.e., *a se*). The personal pronouns may in this case, as well as in the conjugation of all Italian verbs, be omitted. When the pronouns *mi*, *ti*, *ci*, *vi*, and *si* come before a verb beginning with a vowel, their final vowel *i* may be omitted and an apostrophe put in its place. In the infinitive mood of these verbs the pronoun *si* must be removed to the end as a suffix; as *van-tár-si*, i.e., *vantare se medesimo*, to boast.

Some verbs are reflective in the strictest sense of the word, and can never be used without the above-mentioned reciprocal pronouns. Every verb may assume the reflective form, having the pronoun *si* added to its infinitive, whenever the action which the verb implies returns back to the subject.

The great majority of the reflective verbs must be conjugated with *essere* instead of *avere*, and their participle must agree in number and gender with the accusative, preceding the verb. For example:—

ACTIVE.	REFLECTIVE.
L'hô in-gan-ná-to, *I have deceived him.*	Mi sóno in-gan-ná-to, *I have deceived myself*, or *I have*
Mi ha in-gan-ná-to, *he has deceived me.*	Égli s'è in-gan-ná-to, *he has deceived himself*, or *he has been mistaken.*

The reflective verbs governing the *dative case of the person* and *the accusative case of the thing* in their compound tenses may be conjugated with *essere* and sometimes with *avere*, and when the accusative case of the thing precedes them, their participle must agree with it; but it remains unchanged when the accusative follows. For example:—

Él-la si è la-ce-rá-to il vi-so, *she has lacerated her* (i.e., *to herself the*) *face.*

done honour)

Sometimes *mi*, *ti*, *ci*, *vi*, *si* may be added as suffixes to all the tenses where they generally precede, as *Pêntomi* for *mi pênto*, etc.

By anticipation it must be stated here that the conjunctive pronouns *mi*, *ti*, *ci*, *vi*, and *si*, before the words *lo*, it; *la*, her; *li*, them (m.); *le*, them (f.); and *ne*, of it, for it, with it, etc., are changed into *me*, *te*, *ce*, *ve*, and *se*.

CONJUGATION OF THE VERB *PENTIRSI, to repent.*

The conjugation of this verb is an example of the combination of the reciprocal or conjunctive pronouns *mi*, *ti*, *ci*, *vi*, and *si* with a verb.

I. INDEFINITE MOOD[1]

Present.

Pentirsi, *to repent.*

Perfect.

Êssersi pentito, *to have repented.*

Future.

Êssere per pentirsi, *to be about to repent.*

Present Participle.

Pentêntesi, *repenting.*

Past Participle.

Pentitosi, pentitasi, pentitisi pentitesi, *repented.*

Present Gerund.

Pentêndosi, *repenting.*

Past Gerund.

Essêndosi pentito, *having repented.*

Future Gerund.

Essêndo per pentirsi, *being about to repent.*

II. INDICATIVE MOOD.

Present.

Sing. Io mi pênto, *I repent.*
Tu ti pênti.
Egli si pênte.
Plur. Noi ci pentiámo.
Voi vi pentíte.
Eglino si pêntono

Imperfect.

Sing. Io mi pentíva, *I repented*
Tu ti pentívi.
Egli si pentíva
Plur. Noi ci pentivámo.
Voi vi pentiváte.
Eglino si pentívano

Indeterminate Preterite.

Sing. Io mi pentíi, *I repented.*
Tu ti pentísti.
Egli si pentì.
Plur. Noi ci pentímmo.
Voi vi pentíste.
Eglino si pentírono.

Determinate Preterite.

Sing. Io mi sóno pentíto, *I have repented.*
Tu ti séi pentíto.
Egli si è pentíto.
Plur. Noi ci siámo pentíti.
Voi vi siéte pentíti.
Eglino si sóno pentíti.

Indeterminate Pluperfect.

Sing. Io mi èra pentíto, *I had repented*
Tu ti èri pentíto.
Egli si èra pentíto.
Plur. Noi ci eravámo pentíti
Voi vi eraváte pentíti.
Eglino si èrano pentíti.

Determinate Pluperfect.

Sing. Io mi fúi pentíto, *I had repented.*
Tu ti fósti pentíto.
Egli si fu pentíto.
Plur. Noi ci fúmmo pentíti.
Voi vi fóste pentíti
Eglino si fúrono pentíti.

Future.

Sing. Io mi pentirò, *I shall repent.*
Tu ti pentirái.
Egli si pentirà
Plur. Noi ci pentirémo.
Voi vi pentiréte.
Eglino si pentiránno.

Future Perfect.

Sing. Io mi sarò pentíto, *I shall have repented.*
Tu ti sarái pentíto.
Egli si sarà pentíto
Plur. Noi ci sarémo pentíti.
Voi vi saréte pentíti.
Eglino si saránno pentíti.

Conditional Present

Sing. Io mi pentirêi, *I should repent.*
Tu ti pentirésti.
Egli si pentirêbbe.
Plur. Noi ci pentirêmmo.
Voi vi pentiréste.
Eglino si pentirêbbero.

Conditional Past.

Sing. Io mi sarêi pentíto, *I should have repented*
Tu ti sarésti pentíto.
Egli si sarêbbe pentíto
Plur. Noi ci sarêmmo pentíti.
Voi vi saréste pentíti.
Eglino si sarêbbero pentíti

III. IMPERATIVE MOOD.

Sing. Pêntiti tu, *repent thou.*
Non ti pentíre, *do thou not repent.*
Pêntasi egli, *or* si pênta.
Plur. Pentiámoci noi.
Pentítevi voi.
Pêntansi eglino, *or* si pêntano eglino.

IV. SUBJUNCTIVE MOOD.

Present.

Sing. Io mi pênta, *I may repent.*
Tu ti pênta.
Egli si pênta.
Plur. Noi ci pentiámo.
Voi vi pentiáte.
Eglino si pêntano.

Perfect.

Sing Io mi sía pentíto, *I may have repented.*
Tu ti sía pentíto.
Egli si sía pentíto.
Plur. Noi ci siámo pentíti.
Voi vi siáte pentíti.
Eglino si síano pentíti.

Imperfect

Sing. Io mi pentíssi, *I might repent.*
Tu ti pentíssi.
Egli si pentísse.
Plur. Noi ci pentíssimo.
Voi vi pentíste.
Eglino si pentíssero.

Pluperfect.

Sing. Io mi fóssi pentíto, *I might have repented.*
Tu ti fóssi pentíto.
Egli si fósse pentíto.
Plur Noi ci fóssimo pentíti.
Voi vi fóste pentíti.
Eglino si fóssero pentíti.

I. REMARKS ON THE INDEFINITE MOOD.

Observe, the pronoun *si* only refers to *the third person singular* or *plural*. A complete conjugation, for example, of the present and past gerunds, being in all persons of frequent use, runs as follows:—

Present Gerund.

Sing. Pentêndomi, *as I repent.*
Pentêndoti.
Pentêndosi.
Plur. Pentêndoci.
Pentêndovi.
Pentêndosi.

Past Gerund.

Sing. Essêndomi pentíto, *as I have repented.*
Essêndoti pentíto.
Essêndosi pentíto.
Plur. Essêndoci pentíti.
Essêndovi pentíti.
Essêndosi pentíti.

CONJUGATION OF THE VERB *PROCURARSELO*, *to procure it* (i.e., *to get, send for, buy it*, etc.).

This verb is an example of the principal combinations of the reciprocal pronouns, and of the relative words *lo*, him or it; *la*, her or it; *li*, them (m.); and *le*, them (f.) with a verb.

I. INDEFINITE MOOD.

Present.

Procurárselo, *to procure it.*

Present Gerund.

Procurándoselo, *procuring it.*

Past.

Èsserselo procuráto, *to have procured it.*

Past Gerund.

Essêndoselo procuráto, *having procured it.*

II. INDICATIVE MOOD.

Present.

Sing. Me lo procúro, *I procure it.*
Te lo procúri.
Se lo procúra.
Plur. Ce lo procuriámo.
Ve lo procuráte
Se lo procúrano.

Imperfect.

Sing. Me lo procuráva, etc., *I procured it.*

Indeterminate Preterite.

Sing. Me lo procurái, etc., *I procured it.*

Determinate Preterite.

Sing Me lo sono procuráto, I *have procured it.*
Te lo séi procuráto.
Se lo è procuráto.
Plur. Ce lo siámo procuráto.
Ve lo siéte procuráto.
Se lo sóno procuráto.

Indeterminate Pluperfect.

Sing. Me lo èra procuráto, etc., *I had procured it.*

Determinate Pluperfect.

Sing. Me lo fúi procuráto, *I had procured it.*

Future.

Sing Me lo procurerò, etc., *I shall procure it.*

Future Perfect.

Sing. Me lo sarò procuráto, etc., *I shall have procured it.*

Conditional Present.

Sing. Me lo procurerêi, etc., *I should procure it.*

Conditional Past.

Sing Me lo sarêi procuráto, etc.

III. IMPERATIVE MOOD.

Sing. Procúratelo (tu), *do thou procure it.*
Non te lo procuráre, *do not thou procure it.*
Se lo procúri (egli).
Plur. Procuriámocelo (noi).
Procurátevelo (voi).
Se lo procúrino (essi).

IV. SUBJUNCTIVE MOOD.

Present.

Sing. Me lo procúri, *I may procure it.*
Te lo procúri.
Se lo procúri.
Plur. Ce lo procuriámo.
Ve lo procuriáte.
Se lo procúrino.

Imperfect.

Sing Me lo procurássi, etc., *I might procure it.*

Perfect.

Sing. Me lo sía procuráto, *I may have procured it.*
Te lo sía procuráto.
Se lo sía procuráto.
Plur. Ce lo siámo procuráto.
Ve lo siáte procuráto.
Se lo síano procuráto.

Pluperfect.

Sing. Me lo fóssi procuráto, etc., *I might have procured it.*

RENDERVISI, *to repair thither*, AND *FUGGIRSENE*, *to run away.*

I. INDEFINITE MOOD.

Present.

Rêndervisi, *to repair thither.* Fuggírsene, *to run away.*

Past.

Esservisi reso, *to have repaired thither.*	Èssersene fuggito, *to have run away.*

Present Gerund.

Rendêndovisi, *repairing thither.*	Fuggèndosene, *running away.*

Past Gerund.

Essêndovisi rendúto, *having repaired thither.*	Essêndosene fuggito, *having run away.*

II. INDICATIVE MOOD.

Present.

Sing.	Io mi vi rêndo,[*] *I repair thither.*	*Sing.*	Io me ne fuggo, *I run away.*
	Tu vi ti rêndi.		Tu te ne fuggi.
	Egli vi si rênde.		Egli se ne fugge
Plur.	Noi vi ci rendiamo.	*Plur.*	Noi ce ne fuggiámo.
	Voi vi ci rendete.[†]		Voi ve ne fuggíte
	Eglino vi si rêndono.		Eglino se ne fúggono.

Determinate Preterite.

Sing.	Io mi vi sono reso, *I have repaired thither.*	*Sing.*	Io me ne sono fuggito, *I have run away.*

Indeterminate Pluperfect.

Sing.	Io mi vi era reso, *I had repaired thither.*	*Sing.*	Io me ne era fuggito, *I had run away.*

III. IMPERATIVE MOOD.

Sing.	Rêndiviti, *do thou repair thither.*	*Sing.*	Fuggitene, *do thou run away*
	Non vi ti rêndere, *do not thou repair thither.*		Non te ne fuggíre, *do not thou run away.*
	Rêndavisi.		Fúggasene.
Plur.	Rendiámovici.	*Plur*	Fuggiamocene
	Rendétevici.		Fuggitevene.
	Rêndanvisi.		Fuggansene

And so on with all the other moods and tenses.

KEY TO EXERCISES.

Ex. 27.—1. She is not capricious 2. I was awake. 3. We were amazed. 4. He was up-stairs. 5 They have been ill. 6 Are we not cautious? 7. I had been in the bath 8. Are they timid? 9. You are lazy. 10 Are you not eccentric? 11. She was asleep. 12. He has been in school. 13 We were out of doors. 14. They have been at table. 15. You were down there. 16. They were up there. 17 We have been to the right hand. 18. Thou wast sleepy

Ex. 28.—1. Be assiduous. 2. They say that I may have been rash. 3. We are kind to all. 4. I should not be so dismal if I were not unwell. 5. Do not be impatient 6 Do not be so childish. 7. He would have been troublesome to all if he had been there. 8. He would not be so thin if he were not consumptive. 9. We should not have been deluded if we had been more circumspect. 10. Be (ye) true and sincere. 11. They would have been more prudent if they had been warned. 12. You will be hoarse. 13. I believe that she may be silly. 14. They would have been here already if they had been quicker.

Ex. 29.—1. Dost thou know what I (may) have? 2. Have mercy on me. 3. We must have a stove. 4 I shall have a valet. 5. It is not possible that you have had so much to do. 6. He wishes that we may have a good idea of him. 7. If thou hadst prudence thou wouldst not have so many enemies. 8. Do you doubt that I may have had reason? 9. It seems to me that you are wrong. 10. He would have had the situation if he had not had enemies. 11. You will have a coachman. 12. We should have had greater pleasure if we had had it to-day. 13. He would have more credit if his conduct were better. 14. It appears that you have a headache. 15. Have courage and precaution. 16. One must have good legs. 17. I do not deny having had it. 18. Having time, he will be able to go there. 19. Having a sore finger, he could not write.

Ex. 30.—1. Is there some engraver here? 2. No, there is none. 3. There are two druggists. 4. I do not believe that there are any of them. 5. Ten years ago. 6. There are always many people. 7. There were nations. 8. There are no means of persuading him. 9. There is no way. 10. Then there is no hope for peace. 11. There was (one) among them who said. 12. There was not (one) who said a word. 13. There is no chance that I should be able to come to the knowledge of it.

Ex. 31.—1. Chi è stato qui? 2. I fratelli del giovane mercante *sono stati* qui a vedere se voi *foste* a casa. 3. *Dove sono* stati essi? 4. Sono stati un pezzo in campagna. 5. Quando sono stati i tuoi genitori con tuo zio? 6. Lunedì scorso, vi erano arrivati avanti il tramontar del sole. 7. Se io non fossi stato ammalato, sarei andato con loro. 8. Si dice ch'il corriere è già ritornato da Parigi, pero ne dubito perchè il tempo *non* e stato favorevole. 9. Essi domandarono dove eravate. 10. Dissi che voi eravate al teatro.

Ex. 32.—1. Tu hai ragione, ed egli ha torto. 2. Il conte aveva molto danaro, ed ora egli è povero. 3. Perchè non è più ricco? 4. Perchè non era economico. 5. Nol credo, probabilmente avremo un temporale. 6. Avrò un nuovo abito da viaggio, il sartore me lo porterà domani. 7. Sii paziente, ed avrai tutto ciò che brami. 8. Mi pare che tu non abbia alcuna costanza nei tuoi buoni proponimenti. 9. Alcuni vogliono sostenere ch'egli non abbia la cognizione necessaria. 10. Dubito che avesse cio che dice.

Ex. 33.—1. Non c'e mezzo di persuadere uno stolto ostinato. 2. Vi fu una volta un filosofo che sosteneva che non v'e un miglior bene d'una mente sana in un corpo sano. 3. Ugenio sostiene che vi sono degli abitanti nella luna. 4. Vi sono qui de contorni ameni e delle belle vedute? 5. Vi sono molti i quali pensano che si possa comodamente imparare la lingua Italiana in tre mesi; e questi medesimi dopo sei mesi di studio non sanno neppure dire. "Ho scritto poc' anzi—Sono sonate le dieci in questo punto—Vorrei ben sapere di preciso," etc.

MENSURATION.—III.

[*Continued from p. 169.*]

LINES AND AREAS OF SURFACE (*continued*).

Problem IV. — Given the chord BE (Fig. 16) and the height or versed sine CD of an arc of a circle, to find the diameter of the circle. We know, by Euc. III. 35, that the rectangle contained by CD, DK equals that contained by BD, DE, that is the square on BD, since CK bisects BE. We thus have the following *Rule:*—Divide the square of half the chord by the height; the quotient will be the diameter, less the height,

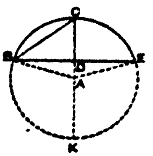

Fig. 16.

$$\text{or } CD \cdot DK = BD^2,$$

$$\therefore DK = \frac{BD^2}{CD}.$$

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[*] *Mi* and *me* in all combinations with particles or pronouns generally stand first. But the particle *vi*, there, stands before the reciprocal pronouns *ti* (2nd pers. sing.), *ci* (1st pers. plur.), and *si* (3rd pers. sing. and plur.).

[†] It would be against harmony to say *voi vi vi rendete*, you repair (i.e., *betake yourselves*) thither. For this reason the particle *ci*, here (*there*), is substituted for *vi*, there, and follows the reciprocal pronoun *vi*, yourselves.

Example.—The chord being 8, and the height 4, what is the diameter of the circle of which the arc is a part?

$$\left(\frac{8}{2}\right)^2 = 16;\ \frac{16}{4} = 4 = \text{diameter, less height.}$$

$$\therefore \text{diameter} = 4 + 4 = 8.$$

Note.—In this example the correctness of the rule is proved, since the diameter = the chord B E, and half of this = radius = 4; *i.e.*, the height of C D.

Exercise 8.

1. The chord of an arc is 18·8, and the height is 8; what is the radius?

2. In levelling for a canal, a certain allowance must be made for the curvature of the earth, since the line of sight is absolutely horizontal, in taking the level. This allowance it is found necessary to make to the extent of 8 inches per mile. Hence, what is the diameter of the earth?

Problem V.—Given the height of the arc, or the versed sine C D (Fig. 16), and the chord of half the arc B C, to find the radius. Since $CD\ .\ DK = BD^2$, add CD^2 to each side and divide by C D, we get

$$CD\ \frac{DK + CD^2}{CD} = \frac{BD^2 + CD^2}{CD},$$

$$\text{or } DK + CD = \frac{BC^2}{2CD};$$

$$\therefore CK = \frac{BC^2}{CD}.$$

Hence the *Rule*:—Divide the square of the chord of half the arc by the height of the arc; the quotient will be the diameter, which halve for the radius. Therefore the height of the arc is the square of the chord of half the arc divided by the diameter; and the chord of half the arc is the square root of the diameter multiplied by the height of the arc, or using the figure in Problem IV.:—

$$CD = \frac{BC^2}{CK}$$

$$\text{and } BC^2 = CK\ .\ CD,$$

$$\text{or } BC = \sqrt{CK\ .\ CD}.$$

Example.—The height of an arc is 16 feet, and the chord of half the arc is 32 feet; what is the diameter of the arc?

$$\frac{32^2}{16} = 1024 \div 16 = 64 = \text{diameter.}$$

Exercise 9.

1. The height of an arc is equal to half the chord of the whole arc, and this is 25 feet. What is the chord of half the arc?*

2. The circular arch of a bridge rises 12 feet above the water, whose level touches the spring of the arch. The radius of the arch is 100 feet. How far is it in a direct line from the spring of the arch to its crown?

3. The arch of a bridge forms a part of a circle. The river beneath rises to the spring of the arch, and is 80 feet wide; and a boat's mast, 16 feet high, can just pass clear of the arch when in mid-stream. With what radius was the arch struck?

Problem VI.—The circumference of a circle being given, to find the length of an arc of it, the number of degrees, etc., it contains being known.

This is a simple and obvious case of proportion. Hence the *Rule*:—As 360° (the number of degrees in the whole circle) is to the number of degrees, etc., in the arc, so is the length of the whole circumference to the length required, or calling θ the number of degrees and x the length of arc required,

$$\frac{x}{\text{circumference}} = \frac{\theta}{360};$$

$$\therefore x = \frac{\theta}{360} \times \text{circumference.}$$

Example. — The circumference of a circle measures 31416 yards; what is the length of an arc of that circle containing 90°?

$$x = \frac{90}{360} \times 31416$$

$$= \frac{31416}{4} = 7854 \text{ yards.}$$

Exercise 10

1. What is the length of a degree at the earth's equator, supposing the circumference of the earth at that part is 24900 miles?

2. The radius of a circular plot of ground is 28 feet. How many degrees will be contained in a portion of the circumference which measures 29 3216 feet?

Problem VII.—To find the length of an arc, when the chords of the whole and of half the arc respectively are given, or when any lines in Fig. 16 are given by which these can be ascertained by previous rules. *Rule.*—Subtract the chord of the whole arc from 8 times the chord of half the arc, and divide the remainder by 3.

Example.—The chord B E of the whole arc (*see* Fig. 16) is 20, and the radius A C is 14; what is the length of the arc?

To find B C, the chord of half the arc—A B, the radius, and B D $\left(= \frac{BE}{2}\right)$ being known—proceed by Euc. I. 47.

Thus,

$$AD = \sqrt{AB^2 - BD^2} = \sqrt{196 - 100} = \sqrt{96}$$

$$= \text{about } 9{\cdot}8;$$

$$DC = AC - AD = 14 - 9{\cdot}8 = 4{\cdot}2;$$

---

* The equality of the two given elements in this example shows them to be the radii of a circle, hence the chord of half the arc, being the hypothenuse, can be found by Euc. I. 47.

$$BC = \sqrt{BD^2 + DC^2} = \sqrt{100 + 17{\cdot}64} = \sqrt{117{\cdot}64}$$
$$= \text{about } 10{\cdot}85.$$

Then, by the rule, $\frac{10{\cdot}85 \times 8 - 20}{3} = \frac{66{\cdot}8}{} = 22{\cdot}26$ = length of arc, about.

EXERCISE 11.

1. The chord of the whole arc is 36 feet 9 inches, and the chord of half the arc is 23 feet 3 inches. What is the length of the arc?

2. The span of a circular arch is 48 feet, and the length from the spring of the arch to its crown is 30 feet in a direct line. How many stones of 9 inches each compose the arch?

There might follow several other problems having reference to the mensuration of lines, such as the finding of the length of the diameter of a circular zone—that is, of the circle of which it forms a part; of the component parts of an ellipse, some of the parts being given; the same of a parabola; but all these, although interesting, are not of such importance as those we have given, and we shall therefore at once proceed to the consideration of the next part of our subject, namely, the mensuration of surfaces—that is, of spaces entirely enclosed by lines.

The necessity for considering the measurement of lines as introductory to that of superficies will be apparent from a consideration of the fact that the area of surfaces are necessarily dependent upon the lines which enclose them, and that, therefore, a knowledge of the one gives us at once the key to a knowledge of the other.

Take, for instance, our first problem under this head:—

PROBLEM VIII.—To find the area of a rectangle (or right-angled parallelogram)—that is, of a four-sided figure, its opposite sides being parallel, and its angles right angles. *Rule.*—Multiply the lengths of any two adjacent sides together; the product is the area.

Let ABCD (Fig. 17) be a rectangle; then AB × AC = area. Hence, if AB and AC be equal, the area is represented by AB^2. If the figure be not rectangular, as EFGH (Fig. 18), find the perpendicular EK, as explained in our last lesson, by multiplying the hypothenuse EG by the natural sine of the angle EGK, and proceed by the above rule.

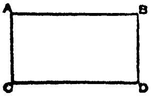

Fig. 17.

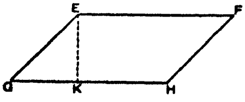

Fig. 18.

EXAMPLE 1.—The two sides of a rectangular parallelogram are 5 and 6; what is its area? *Ans.* 5 × 6 = 30.

EXAMPLE 2.—The side of a square is 10; what is its area? *Ans.* 10 × 10 = 100.

EXAMPLE 3.—The sides of an oblique-angled parallelogram (Fig. 18) are 15 and 10, and the angle at G is 30°; what is its area?

Side EG = 10; natural sine of angle EGK or 30° = ·5. Hence EK = 10 × ·5 = 5; and area = EF × EK, or 15 × 5 = 75.

EXERCISE 12.

1. The sides of a rectangular parallelogram are respectively 25 and 4; what is its area?

2. A square table is 3 feet across either side; how many squares of 1 inch could be marked out upon it?

3. A deal board is 11 feet long and 11 inches wide, the ends being square. We want to cut it up into pieces 1 foot long and 1 inch wide; how many can we cut?

4. The area of a square field is 1 acre; how long is each side in links and yards?

5. A rectangular space, intended for planting, is 300 yards long and 220 yards broad. If we cut a path across it the longest way, 4 feet wide, how much space will remain available for planting?

6. A street, 30 feet wide and 1 mile long, has to be paved at a cost of 4s. per square yard; what will the total cost be?

7. The adjacent sides of an acute-angled parallelogram are 20 and 15 feet; at what angle must they incline so that the area of the parallelogram shall be 259·8 feet?

8. What would be the area of the above figure if the angle were 30° instead of 60°?

PROBLEM IX.—The diagonal of a square being given, to find its area? Let ABCD be the square whose diagonal BD is given.

By Euc. I. 47 we know that

$$AB^2 + AD^2 = BD^2,$$
$$\text{or } 2AB^2 = BD^2;$$
$$\therefore AB^2 = \frac{BD^2}{2}.$$
$$\therefore AB = \sqrt{\frac{BD^2}{2}}.$$

We then have the *Rule*:—Square the diagonal and halve the result.

EXAMPLE 1.—The diagonal of a square is 10; what is its area?

$$10^2 = 100;\ \frac{100}{2} = 50, \text{ area.}$$

EXAMPLE 2.—What is the length of the side of the above square?

$$\text{Area} = 50;\ \sqrt{50} = \text{about } 7{\cdot}07.$$

Hence, approximately, the side of a square is to its diagonal as 7 to 10.

EXERCISE 13.

1. The area of a square is 100 square feet; what is the length of the diagonal?

2. The diagonal of a square is 4 chains; required the area of the square.

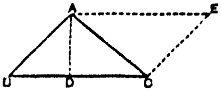

Fig. 10.

3. The area of a square is 1 acre, 1 rood; what is the length of the diagonal?

PROBLEM X. — To find the area of a triangle, the base and altitude being given. Let A B C (Fig. 19) be a triangle, and A D its altitude.

By Euc. I. 41 we know that

$$\text{Area of ABC} = \tfrac{1}{2}\ \text{Area of ABCE}.$$
$$\therefore \text{ by Problem VIII.}$$
$$\text{Area of ABC} = \tfrac{1}{2}(\text{BC} \times \text{AD})$$

Rule.—Multiply the base by half the altitude; the product is the area.

EXAMPLE.—The base of a triangle is 20, and the altitude is 10; what is the area of the triangle?

$$20 \times \frac{10}{2} = 100, \text{ area of triangle.}$$

EXERCISE 14.

1. The base of a triangle is 43, and the altitude 21; required the area.

2. The base of a triangle is 150 yards, and the altitude 120 yards; required the area in acres, roods, etc.

3. The hypothenuse of a right-angled triangle is 68, and the base 24; what is the area?

4. The side of an equilateral triangle is 6; what is its area?

5. The three sides of a triangle are respectively 20, 21, and 29 poles; required its area in acres, roods, and poles.

PROBLEM XI.—To find the area of a trapezium.*

Rule.—Divide the figure into two triangles, by drawing a diagonal; then compute the areas of the triangles separately, by previous rules, and add these areas together.

If the figure be a trapezoid, *i.e.*, has only two of its sides parallel, as A B C D, the area $= \frac{\text{AB} + \text{DC}}{2} \times \text{AE}$; or to find area of a trapezoid, add together the two parallel sides and multiply half this sum by the perpendicular distance between the same two sides.

The correctness of the working may be proved by drawing the *opposite* diagonal, and repeating the computation. The two results will agree if both calculations are correct.

EXAMPLE 1.—The lengths of the four sides of a trapezium A B C D (Fig. 20) are as follows:— A B = 20; B C = 12; C D = 7; and D A = 18, and the diagonal B D is 18. What is its area?

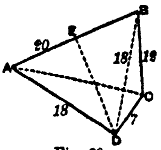

Fig. 20.

In the triangle A B D, the two sides A D and D B being equal, its area is double that of A E D.

$$\text{Then ED} = \sqrt{18^2 - \left(\frac{20}{2}\right)^2} = \sqrt{324 - 100}$$
$$= \sqrt{224} = 15, \text{ nearly.}$$

Therefore area of A E D = A E × $\frac{\text{ED}}{2}$, or 10 × 7·5 = 75; and A B D = 2 A E D or 150.

Again, in the triangle B C D, the area is found as follows, the three sides being given:—

$$\frac{\text{BC} + \text{CD} + \text{DB}}{2} = \frac{12 + 7 + 18}{2} = \frac{37}{2} = 18{\cdot}5.$$

$$18{\cdot}5 - 12 = 6{\cdot}5(a);\quad 18{\cdot}5 - 7 = 11{\cdot}5(b);$$
$$18{\cdot}5 - 18 = {\cdot}5(c).$$

$$\begin{array}{r} 18{\cdot}5 \\ 6{\cdot}5(a) \\ \hline 120{\cdot}25 \\ 11{\cdot}5(b) \\ \hline 1382{\cdot}875 \\ {\cdot}5(c) \\ \hline 691{\cdot}4375 \end{array}\qquad \text{Area of BCD} = \sqrt{691{\cdot}4375}$$
$$= 26{\cdot}3, \text{ nearly.}$$

Then area of trapezium = areas of A B D + B C D or 150 + 26·3 = 176·3. *Ans.*

In actual measurements, the diagonal A C may be ascertained, and the areas of the two triangles A B C and A C D found. Their sum will be found to be as above, provided the measurements and calculations are correctly performed.

Note.—In the application of this, and any other rule for the measurement of surfaces as applied to land surveying, too many checks on the correctness of the results cannot be taken.

EXERCISE 15.

1. The four sides of a trapezium are respectively 20, 16, 12, and 14; the diagonal across between the two most obtuse angles (draw the figure) is 14. Required the area of the trapezium.

2. The four sides of a trapezium are 628, 464, 457, and 733, and the diagonal from the angle between the two shortest sides of the opposite angle is 835. Required its area.

3. A trapezoid has its two parallel sides 7 and 12 feet, and the perpendicular between them measures 6 feet. Find the area of the trapezoid.

To this as well as to the other exercises that have been given as necessary appendages to the different problems, the learner can easily add examples for practice by substituting other numbers in the various examples in each exercise; or by drawing triangles, parallelograms, trapeziums, etc., according to scale, and working out their contents for their dimensions.

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* A trapezium is a quadrilateral figure (four-sided) in which no two of its sides are parallel. The problem may be extended to finding the area of any quadrilateral figure.

KEY TO EXERCISES.

EXERCISE 1.

1. 5 ft. 10·7 in. approximately.
2. 855 feet.
3. 1 foot 4 inches.
4. 5 feet 11¾ inches nearly.
5. 44 feet.
6. ·866025, etc.

EXERCISE 2.

1. √24 or 4·899 nearly.
2. 6.
3. 12.
4. 11·3538.
5. Nearly 1 acre, 3 rood, 13¾ poles.
6. 4500.
7. About 5·0056.
8. 240 feet.

EXERCISE 3.

1. 84.
2. 250·8.
3. Length of edge, 13·11 feet; area of pyramid, 423·76 feet.

EXERCISE 4.

1. About 8·91.
2. 7° 9′.
3. About 51·43.

EXERCISE 5.

1. 2·8868.
2. 1.
3. 28.

EXERCISE 6.

1. Nearly 180·5, and about 166·5.
2. Nearly 1·597, and nearly 6·374.
3. About 1·051.

EXERCISE 7.

1. 25·1827.
2. 25000·8528 miles.
3. Nearly 7925.
4. About 18·064.
5. Nearly 1 foot 8·53 inches.
6. Nearly 1123 miles.

LATIN.—XL.

[*Continued from p.* 183.]

CICERO.

THE following is one of Cicero's letters to his friend Atticus, which will serve as a specimen of his style in this branch of literature:—

CICERO.—"EPISTOLAE AD ATTICUM," I. 15.

Asiam Quinto, suavissimo fratri, obtigisse audisti: non enim dubito, quin celerius tibi hoc rumor, quam ullius nostrum litterae nuntiarint. Nunc quoniam et laudis avidissimi semper fuimus, et praeter ceteros φιλέλληνες et sumus et habemur, et multorum odia atque inimicitias reipublicae causa suscepimus. παντοίης ἀρετῆς μιμνήσκεο, curaque et effice, ut ab omnibus et laudemur et amemur. His de rebus plura ad te in ea epistola scribam, quam ipsi Quinto dabo. Tu me, velim, certiorem facias, quid de meis mandatis egeris, atque etiam, quid de tuo negotio. Nam ut Brundisio profectus es, nulla mihi abs te redditae litterae. Valde aveo scire, quid agas. Idib. Mart.

Cicero's brother Quintus has just obtained the government of the province of Asia (Asia Minor), and Cicero writes to Atticus to ask him to endeavour to strengthen his hands.

NOTES.

Fuimus. Cicero by this expression completely identifies himself with the welfare of his brother.

Φιλέλληνες. Cicero very frequently makes use of Greek words and phrases in his familiar letters, just as we often use French; a knowledge of Greek being considered in a Roman a mark of a polite education, as French with us.

Ea epistola. There are extant some letters of Cicero to his brother, on the occasion of his appointment, full of excellent advice on these points.

Tu me, velim, etc. "Please let me know."

Brundisio. A town on the south-west coast of Italy, the usual starting-point for Greece.

Idib. Mart. Sc. *Idibus Martiis dato*, "posted on the 15th of March."

You have already had some experience in translating *Ovid*. We shall now give you one or two more passages from the works of the elegiac poet:—

OVID.—"TRISTIA," I. III. 1—34.

Cum subit illius tristissima noctis imago,
Quae mihi supremum tempus in urbe fuit:
Cum repeto noctem, qua tot mihi cara reliqui,
Labitur et oculis nunc quoque gutta meis.
Jam prope lux aderat, qua me discedere Caesar
Finibus extremae jusserat Ausoniae.
Nec mens, nec spatium fuerat satis apta paranti
Torpuerant longa pectora nostra mora.
Non mihi servorum, comitis non cura legendi,
Non aptae profugo vestis opisve fuit.
Non aliter stupui, quam qui Jovis ignibus ictus
Vivit, et est vitae nescius ipse suae.
Ut tamen hanc animo nubem dolor ipse removit,
Et tandem sensus convaluere mei;
Alloquor extremum moestos abiturus amicos,
Qui modo de multis unus et alter erant.
Uxor amans flentem flens acrius ipsa tenebat,
Imbre per indignas usque cadente genas.
Nata procul Libycis aberat diversa sub oris;
Nec poterat fati certior esse mei.
Quocunque aspiceres, luctus gemitusque sonabant;
Formaque non taciti funeris intus erat.
Femina, virque, meo pueri quoque funere moerent;
Inque domo lacrymas angulus omnis habet.
Si licet exemplis in parvo grandibus uti;
Haec facies Trojae, cum caperetur, erat.
Jamque quiescebant voces hominumque canumque,
Lunaque nocturnos alta regebat equos:
Hanc ego suspiciens, et ab hac Capitolia cernens,
Quae nostro frustra juncta fuere Lari;
Numina vicinis habitantia sedibus, inquam,
Jamque oculis nunquam templa videnda meis;
Dique relinquendi, quos Urbs habet alta Quirini;
Este salutati tempus in omne mihi.

NOTES.

Subit (*sc. in mentem*). "Comes into my mind."

Nunc quoque. "Even now, after all these years of exile."

Finibus extremae Ausoniae (for *finibus extremis Ausoniae*), "the furthest limits of Italy" *Ausonia*, a name given to Italy, from an ancient tribe, the Ausones, who were said to have inhabited it.

Servorum. Supply *legendorum* from *legendi.*

Vestis and *opis* are genitives after *cura* in the previous line, and must have *legendae* supplied in the construction.

Non aliter—quam, "as much as."

Jovis ignibus, "the thunderbolt"—supposed in the Roman mythology to be Jove's special weapon.

Vivit, etc Compare Tennyson's "Princess," vi. 2, 3.—

> "As in some mystic middle state I lay,
> Seeing I saw not, hearing not I heard."

Extremum. Neuter used adverbially, "for the last time."

Non taciti—i.e., attended with loud lamentation.

Intus, "within the house."

Ab hac, "looking from her on to the Capitol."

Frustra, "to no purpose," because it could do nothing to assist him. Probably an allusion to M. Manlius Capitolinus, the defender of the Capitol, whom the people refrained from putting to death while he was in sight of the scene of his bravery.

Jam—nunquam, "never more"

Quirini. Romulus, the founder of Rome, was worshipped under this title.

The next extract is taken from an elegy embodying the complaints of an ill-used walnut tree:—

OVID.—"NUX, ELEGIA," 1—20.

Nux ego juncta viae, cum sim sine crimine vitae,
  A populo saxis praetereunte petor.
Obruere ista solet manifestos poena nocentes,
  Publica cum lentam non capit ira moram.
Nil ego peccavi; nisi si peccare videtur,
  Annua cultori poma referre suo.
At prius arboribus, tum, cum meliora fuere
  Tempora, certamen fertilitatis erat.
Cum domini memores sertis ornare solebant
  Agricolas, fructu proveniente, deos.
Saepe tuas igitur, Liber, miratus es uvas;
  Mirata est oleas saepe Minerva suas.
Pomaque laesissent matrem; ni subdita ramo
  Longa laboranti furca tulisset opem.
At postquam platanis, sterilem praebentibus umbram,
  Uberior quavis arbore venit honos;
Nos quoque frugiferae (si nux modo ponor in illis)
  Coepimus in patulas luxuriare comas.
Nunc neque continuos nascuntur poma per annos;
  Uvaque laesa domum, laesaque bacca venit.

NOTES.

Juncta viae, "hard by the way-side."

Cum sim, "although I am."

Petor, "am pelted." Cf. "Me Galataea *petit* malo" (Virg. "Ecl.").

Manifestos, "caught in actual crime," "red-handed," in *flagrante delicto.*

Non capit, "does not admit of."

At prius, etc. "In old days, when times were better, the trees used to vie with each other in productiveness."

Memores, "with due attention."

Agricolas, used as an adjective. So we find *victor exercitus*, *domina hasta*, etc.

Liber, a name of Bacchus, god of wine.

Tuas, "sacred to thee."

Suas. When there was a contest between Neptune and Minerva which should give the best gift to mankind, Neptune struck the earth with his spear, and the horse appeared; Minerva in a similar way produced the olive.

Laesissent—i.e., by weighing down and breaking the bough.

Quavis arbore—i.e., *honore cujusvis arboris.* This abbreviated form of comparison (brachylogy of comparison) is not uncommon. Thus we find *κόμαι χαρίτεσσιν ὁμοίαι*, *hair like the graces*, for *hair like that of the graces;* and an English poet has—

> "They for their young Adonis might mistake
> The soft luxuriance of thy golden hair"—

i.e., for the hair of their young Adonis.

In illis — i e., among the fruit-bearing trees. The general sense of this passage is, as trees have come to be cultivated more for their foliage than their fruit, so the walnut-tree, following the same fashion, grows wide-spreading leaves.

You are by this familiar with the style of Tacitus. But we shall give you one specimen each of his great works—the "Annals" and "Histories."

The following extract is a delineation of the character of one of the most infamous men of an infamous age, and will serve as a specimen of Tacitus' peculiar power in this style of writing:—

TACITUS.—"ANNALS," IV. 1.

C. Asinio, C. Antistio consulibus nonus Tiberio annus erat compositae reipublicae, florentis domus (nam Germanici mortem inter prospera ducebat), cum repente turbare fortuna coepit, saevire ipse aut saevientibus vires praebere. Initium et causa penes Aelium Sejanum cohortibus praetoriis praefectum, cujus de potentia supra memoravi: nunc originem, mores, et quo facinore dominationem raptum ierit, expediam. Genitus Vulsiniis, patre Seio Strabone equite Romano, mox Tiberium variis artibus devinxit adeo, ut obscurum adversum alios sibi uni incautum intectumque efficeret; non tam sollertia (quippe isdem artibus victus est), quam deûm ira in rem Romanam, cujus pari exitio viguit ceciditque. Corpus illi laborum tolerans, animus audax; sui obtegens, in alios criminator; juxta adulatio et superbia; palam compositus pudor, intus summa apiscendi libido; ejusque causa modo largitio et luxus, saepius industria ac vigilantia, haud minus noxiae, quoties parando regno finguntur.

NOTES.

Germanici mortem. Germanicus, a member of the imperial family, was looked upon by Tiberius as a rival, owing to his great success as a general, and consequent popularity. In the previous year, on his return to Rome from a successful campaign in Germany, he died suddenly, as it was believed, by poison administered at the instigation of Tiberius.

Ipse (Tiberius). Supply *coepit* with *saevire*.

Initium, sc. *saeviendi*, etc.

Cohortibus praetoriis. These were the emperor's body-guard, who were quartered in Rome.

Raptum ierit, "he went about to seize." *Raptum* is the supine in *-um* after *ierit*, a verb of motion, and governs *dominationem*.

Vulsiniis, a town in Etruria

Obscurum. Tacitus frequently dwells upon this especial feature in the character of Tiberius—his *dissimulatio*, or habit of concealment.

Sibi uni—*i.e.*, to Sejanus.

Isdem artibus. Because he was afterwards crushed by the craft of Tiberius.

Pari exitio. Since he killed so many in his life. and at his death involved so many in his ruin. Translate, "To which he was equally fatal both in the height of his power and in his death"

Juxta. "At once fawning and imperious," or more literally "servility and pride were united in him."

Causa, abl., "and to gain this he employed."

Haud minus noxiae, "no less dangerous"—*i.e.*, than *largitio* and *luxus*.

without connecting particles, and carefully balanced one against the other while the choice of words and the formation of the sentences is studiously varied.

The following singular version of the early history of the Jews will, no doubt, be read with interest:—

TACITUS —"HISTORIES," V. 3.

Plurimi auctores consentiunt, orta per Aegyptum tabe quae corpora foedaret, regem Bocchorim adito Hammonis oraculo remedium petentem, purgare regnum et id genus hominum ut invisum deis alias in terras avehere jussum. Sic conquisitum collectumque vulgus, postquam vastis locis relictum sit, caeteris per lacrimas torpentibus, Moysen unum exsulsum monuisse ne quam deorum hominumve opem expectarent utrisque deserti, sed sibimet, duce coelesti, crederent, primo cujus auxilio praesentes miserias pepulissent. Adsensere, atque omnium ignari fortuitum iter incipiunt; sed nihil aeque quam inopia aquae fatigabat. Jamque haud procul exitio totis campis procubuerant, cum grex asinorum agrestium e pastu in rupem nemore opacam concessit. Secutus Moyses conjectura herbidi soli largas aquarum venas aperit; id levamen, et continuum sex dierum iter emensi, septimo pulsis cultoribus obtinuere terras in quis urbs et templum dicata. Moyses quo sibi in posterum gentem firmaret, novos ritus contrariosque ceteris mortalibus indidit. Profana illic omnia quae apud nos sacra; rursum concessa apud illos quae nobis incesta. Effigiem animalis quo monstrante errorem sitimque depulerant, penetrali sacravere, caeso ariete velut in contumeliam Hammonis.

NOTES.

Vastis locis, "in the desert"; *vastus*, in addition to the idea of size, conveying that of emptiness.

Per lacrimas torpentibus, "lamenting and despairing."

Duce coelesti, ablative absolute, "their guide being a heavenly one."

Pepulissent, "they would drive away." If the sentence was in *Oratio Recta*, giving the words of the speaker, it would be *pepuleritis*, the future perfect; hence the past tense in the *Oratio Obliqua*.

Conjectura herbidi soli, "judging from the verdant nature of the ground."

Id levamen, "thus they obtained relief."

Urbs et templum dicata. An abbreviated form of expression for *urbis condita et templum dicatum*.

Animalis. It was a common belief among the ancients that the Jews worshipped the ass. Possibly the idea may have sprung from a distorted idea of the figures of the cherubim

JUVENAL.

D. Junius Juvenalis, the greatest of the satirists of Rome—or, perhaps, of any other country—was a contemporary of the Emperor Domitian; he is said to have been born about A.D. 48, and died 128. He lived at a time when all sorts of vice and corruption ran riot in Rome; and he has depicted the faults of his age with no sparing hand. Horace, who was a sufficiently keen satirist, nowhere approaches Juvenal in the unflinching severity with which he attacked the vices which he saw around him. His writings are frequently obscure, owing to the difficulty we have in understanding the various allusions he makes to people of the day, of whom we know little or nothing, but his style is eminently pure and finished. Sixteen of his satires are all that have come down to us of his writings; the metre is hexameter, but, as is usual in writings of this sort, not bound down by the fixed rules which obtain in epic or didactic poetry.

In the first extract the poet states the range which he proposes to himself to take:—

JUVENAL.—"SAT.," I. 81—116.

Ex quo Deucalion, nimbis tollentibus aequor,
Navigio montem ascendit sortesque poposcit,
Paulatimque anima caluerunt mollia saxa
Et maribus nudas ostendit Pyrrha puellas,
Quidquid agunt homines, votum, timor, ira, voluptas,
Gaudia, discursus, nostri est farrago libelli. [85
Et quando uberior vitiorum copia? quando
Major avaritiae patuit sinus? alea quando

Hos animos? Neque enim loculis comitantibus itur
Ad casum tabulae, posita sed luditur arca. 90
Proelia quanta illic dispensatore videbis
Armigero! Simplexne furor, sestertia centum
Perdere, et horrenti tunicam non reddere servo?
Quis totidem erexit villas? quis fercula septem
Secreto coenavit avus? Nunc sportula primo 95
Limine parva sedet, turbae rapienda togatae.
Ille tamen faciem prius inspicit et trepidat, ne
Suppositus venias ac falso nomine poscas.
Agnitus accipies. Jubet a praecone vocari
Ipsos Trojugenas: nam vexant limen et ipsi 100
Nobiscum. *Da praetori, da deinde tribuno!*
Sed libertinus prior est. *Prior*, inquit, *ego adsum*
Cur timeam dubitemve locum defendere, quamvis
Natus ad Euphraten, molles quod in aure fenestrae
Arguerint, licet ipse negem? Sed quinque tabernae 105
Quadringenta parant. Quid confert purpura major
Optandum, si Laurenti custodit in agro
Conductas Corvinus oves? Ego possideo plus
Pallanta et Licinis. Exspectent ergo tribuni;
Vincant divitiae; sacro nec cedat honori, 110
Nuper in hanc urbem pedibus qui venerat albis;
Quandoquidem inter nos sanctissima Divitiarum
Majestas: etsi funesta Pecunia templo
Nondum habitas, nullas nummorum ereximus aras,
Ut colitur Pax atque Fides, Victoria, Virtus, 115
Quaeque salutato crepitat Concordia nido.

NOTES.

Deucalion. Alluding to the old legend of Deucalion's flood, after which he and his wife Pyrrha re-people the earth. According to the legend, they both threw stones over their heads backwards; those that Deucalion threw were turned into men, while those thrown by Pyrrha became women.

Sortes. "An oracular answer."

Quidquid, etc. "Everything that has been done or felt by man from that day to this."

Farrago is "the medley of our book."

Hos animos (supply *habuit*). "Since when had the vice such power?"

Posita—arca. They not only stake their money in play, but the chest which contains it. "They stake the money-chest, and play for it."

Dispensatore—armigero. "When the steward supplies the weapons."

Sportula. The dole given by patrons to their clients. Now Juvenal complains it is given away wantonly to those who do not really need it.

Trojugenas, "high-born." According to the legend that Latium was peopled by the descendants of Æneas.

Molles fenestrae. The effeminate holes bored in the ears for earrings.

Major. The broad stripe of purple on the robe; the sign of patrician rank.

Sacro honori. The tribuneship, the holders of which office were held inviolate (*sacrosancti*).

Pedibus albis, "with his feet marked with chalk." The sign of a slave for sale.

Quandoquidem. "Since really money is the only deity we worship, although she has as yet no temple like Peace, Honour, and the rest whom we pretend to worship."

KEY TO EXTRACT FROM CICERO.

"IN CATILINAM," I. 1.

How much further, Catiline, are you going to insult our forbearance? How long will this mad folly of yours continue to escape our vengeance? What limit shall bound the reckless course of your unbridled audacity? The Palatine guarded by night, sentries posted in the city, the people in a scare, all good citizens banded together, this our senate house most strongly defended, even the very glances of those around us—have all these things failed to impress you? Can you help feeling that your plots are discovered, or seeing that your conspiracy is already checked and stifled by the fact that everyone here knows all about it? Do you think there is a man among us who knows not what you did last night, or the night before, where you were, whom you summoned to your councils, or what plans you adopted? O the depravity of our age! The senate is cognisant of this—the consul sees it—and yet this man lives? Did I say lives? Why, he comes into the senate, he takes part in our political discussions, and all the time his eye is noting each one of us, and marking him down for assassination; while we—brave men that we are—are supposed to be doing our duty by the state if only we avoid his frenzy and murderous attacks. In justice, Catiline, the consul's order should long ago have doomed you to death and the destruction you have all the while been plotting against us. Did not Publius Scipio, the chief pontiff, a man of the highest position, put to death in his private capacity Ti. Gracchus, who was only weakening the constitution in a moderate degree; and shall we, the consuls, put up with Catiline, who is eager to desolate the whole earth with sword and fire? I say nothing of the deeds of the remote past, such as C. Servilius Ahala slaying with his own hand Sp. Maelius, who was aiming at a revolution. There was once, but it is gone, such a feeling of honour in our state that the brave citizens would punish a traitor among their fellows more severely than their bitterest foe. We have a decree of the senate passed against you, Catiline, in stringent and severe terms. The senatorial order does not withhold from the state the benefit of its talent and authority; it is ourselves—I say it openly—ourselves, the consuls, who are wanting in our duty.

THE ORGANS OF SENSE.—III.

[Continued from p. 176.]

II.—THE EAR.

A MAN who had been born blind, when asked what he supposed scarlet was like, replied, "Like the sound of a trumpet." The reply is startling, because it shows how dependent the mind is upon the senses for its ideas. No one who could both see and hear would ever think of comparing sound with light, or tone with colour.

But though the sensations conveyed to the brain by the eye-nerve and the ear-nerve are so different as to be incomparable, there is much resemblance between sound and light. They obey the same laws. Sound can be absorbed, reflected, and refracted at the surface of bodies, as we have seen light is; and, moreover, both consist of vibrations, or waves, succeeding one another at regular intervals, like the enlarging circles which follow one another and break upon the banks when a stone is thrown into the middle of a still pond, and disturbs the glassy surface of the water.

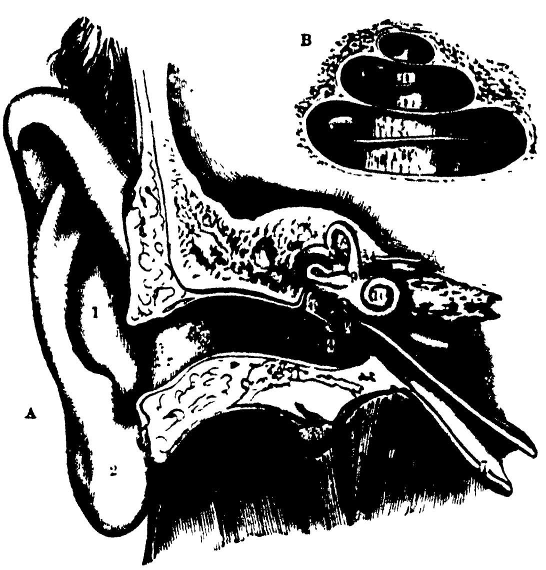

Fig. 6.—A, The Human Ear. B, Section showing the Hollow of the Cochlea.

Reference to Nos. in A.—1, pinna; 2, lobule; 3, tube; 4, tympanic membrane; 5, incus, or anvil; 6, malleus, or hammer; 7, eustachian tube; 8, semi-circular canals; 9, vestibule, 10, cochlea.

Though there are these points of similarity as to the essential nature and qualities of light and sound, there are also great differences. Light travels with a rapidity which, for all appreciable distances—that is, for all earthly objects—is instantaneous; while sound travels, relatively, very slowly, and, when common air carries it, it goes only 1,093 feet during each second of time. Again, while the vibrations of light are so rapid that it is impossible to know them to be vibrations but by reasoning upon its effects, the waves of sound may be often observed by the eye when they are propagated through, or originated from, a solid body, as when we see a cord or glass vessel respond to a musical note, or give out a sound when struck. Sound, too, is the vibration of the substances themselves—which substance we can feel, or see, or know by means of other senses—while light is supposed to be the vibration of some fluid—the so-called ether—which is imponderable, or, in other words, has no weight, and of which we know nothing except by the eye.

The waves of sound, then, being coarser and more liable to interference than the waves of light, it follows that the ear cannot be so good an indicator of the *direction* of sound as the eye is of the direction of a luminous object. Indeed, the ear can of itself scarcely give us any idea of direction. If the sound be short and sharp, like the piercing shriek of the bat, or even the cry of the partridge, and it be not repeated so often as to let us try experiments on it, by turning the head this way and that, it is very difficult to tell whence the sound comes, even to the extent of a whole quadrant of the horizon. Upon this fact ventriloquism depends for its success. The idea of the direction of sound being inferential, and not much dependent upon the sense—being, in fact, owing to the operation of the mind, and not to that of the ear — the ventriloquist has only to direct the mind where to expect the sound, and then to make a sound of just such a pitch of intensity, and just such a tone, as the sound would have if it came from that quarter, to completely impose on the ear of the listener as to the direction whence it comes.

But although the ear is at fault as regards direction, the accuracy of some of its other notifications is wonderful in the extreme. It can note not only the likeness and difference of musical sounds, but of their harmonies when many are sounded together, and a fine ear will detect an erring note when a thousand instruments are sounded. The recognition of slight differences is truly wonderful when we consider that not only can the ear know when the same note is sounded by instruments of different kinds (though physicists are unable to tell us how there can be any difference, the number of vibrations in a second being the same, and the medium identical), but very slight differences in the same kind of instruments, such as whether there is one per cent. more or less of a metal in an alloy of which an organ-pipe is made, or of which a bell is cast, are observed so shrewdly, that these matters have to be attended to with the nicest care. A violin must not only be of a certain shape, but the wood of which it is composed must be of a certain age, to produce the best instrument; and these observed differences are carried to such a nicety that fiddles made in a certain part of Italy, in a certain year, are considered the best, and will command almost fabulous sums. Yet all this depends upon what is called *timbre*, a word which gives a name to a something which is entirely dependent on the delicacy of our sense of hearing, but which has not received any other explanation.

Though we cannot directly connect these niceties of sense with the intricacies of complication in the organ of hearing, these latter will be seen to be so numerous and peculiar when we describe the ear, that one is not surprised that much connected with sound is unexplained, because there are so many structures connected with the organ which has been given us as the recipient and interpreter of sound at the use of which we can hardly guess

That which is usually called the ear is familiar to everyone as the external semi-circular cartilage, closely invested with skin, and ending below in a soft lobule, which is sometimes the support of barbarous pendants. This structure, which, when well formed, has a beauty of its own that needs no supplement or advertisement, is but a remote appendage to the true ear. Though it in some sort collects sound, and protects the orifice which leads down towards, not to, the true ear, it is non-essential, and can be dispensed with without much inconvenience; so that some of our poor ancestors, who found that they could not retain both good external ears and good consciences, like William Prynne in the time of Charles I. and the Star Chamber, suffered less real loss than might have been anticipated.

The external gristly ear is called the pinna, and though flattened as to its general surface, is somewhat folded into ridges and furrows, there being a rim round the outside and a channel within this, which deepens and widens as it runs first upward, along the back part, then downward along the fore part to a central crypt. From this crypt the passage becomes narrower as it runs forward and inward to the pit of the ear. Sound, no doubt, is conveyed along this canal in the same direction as we have described its course. If the pinna were quite flat, sound would rebound from it; but as it is so shaped, sound is caught and reflected round the canal from point to point, as it is reflected round the Whispering Gallery of St. Paul's, and finally delivered down the tube of the ear.

The tube is an inch and a half deep, and its innermost half enters one of the bones of the head, called the temporal bone, and in this bone all the other parts of the ear are enclosed and protected. At the bottom of the tube is an oval membrane stretched across the passage, and barring the entrance to all external objects. Behind this is a roundish irregular cavity, filled with air. This stretched fibrous membrane bounding the air cavity, naturally suggests the idea of a drum, shaped like a kettle-drum; and hence the cavity is called the tympanum, from a Latin word meaning *drum*, and the parchment-like tissue the membrane of the drum, or tympanic membrane. It differs, however, from a kettle-drum in that several orifices open into it, and it contains structures to be described presently.

On the farther side of the drum is the true ear, completely encased in bone, except at two very small holes, which are closed with membrane. The larger and upper aperture is called the oval hole, and the smaller and lower the round hole. From the membrane of the tympanum to the membrane of the oval hole stretches a chain of bones, whose shape is seen in the engraving. The outer one, next the parchment of the drum, is called the hammer (*malleus*). It has three processes, or projections, two of which are long, so that, rather than hammer, it might be called a woodcutter's beetle. One of these processes, called the handle, is attached to the centre of the membrane, which it makes tight when pulled inward by a small muscle, and lax when another muscle acts on it.

The former operation is probably the action which we unconsciously cause when we consciously listen. The head of the hammer is applied to another bone called the anvil (*incus*). It has two processes, one for its suspension to the wall of the tympanic cavity, and the other to connect it with the third or stirrup-bone (*stapes*). This bone is more like the article it is named from than the others are, and the foot-part of the stirrup is applied to the oval membrane, which it nearly covers. These bones can move a little in relation to one another, and their actions are limited by small muscles, but they usually act together as if in one piece, playing round an axis which runs through the heads of the hammer and anvil, so that when the tympanic membrane is thrust in and out by vibration, the membrane of the oval hole is made to vibrate correspondingly. The round hole is open to the influence of sound conveyed through the air of the tympanum; but whether this be its function, or it merely allows the fluid of the internal ear to be more readily thrown into vibration in the passage it fills—in other words, whether it be a hole for the entrance or exit of vibrations—seems hard to tell.

The fore-part of the drum cavity is connected with the throat by a passage, which runs forwards and downwards to open in the gullet behind the nose and mouth. Through this passage the cavity is kept supplied with renewed air at the same pressure as the external air. The reader may be conscious of the existence of these passages to the ears from the throat by preventing the air from rushing out of the mouth and nose, while he forces it up from his lungs. The cavity of the drum will then be distended with air; hearing will be less perfect, by the unnatural tension of the membranes, and there will be a slight singing in the ear. With a little practice, air may be conveyed through the mouth to the drum without entering the lungs, and thus gases have been applied as remedies to diseases of the ear. But the exclusion of these from the lungs is difficult, and cannot be relied on. One of our greatest aurists, when pursuing his philanthropic and scientific investigations on the effect of chloroform and prussic acid applied thus, died, because he could not exclude the latter deadly poison from his lungs as he had supposed he could. The proper, or essential ear, consists of a chamber longer than broad, communicating on its upper and outer side with three semi-circular canals, and at its front inner end with a cavity shaped like a snail-shell.

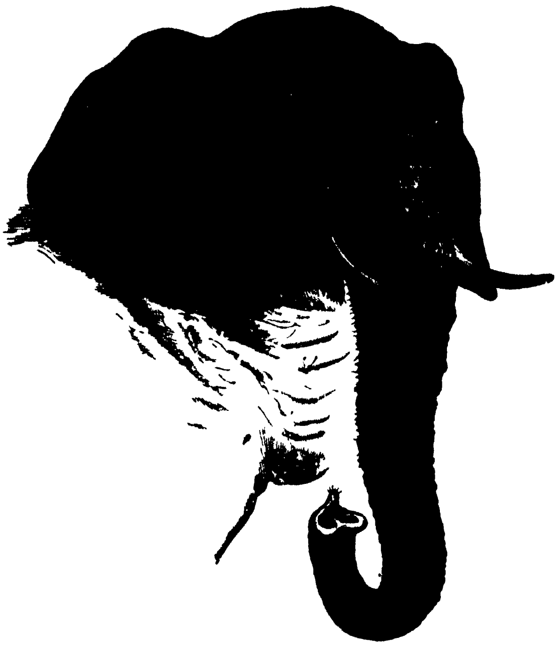

Fig. 7.—Head of an African Elephant.

The chamber is called the vestibule; this and the semi-circular canals are called together the labyrinth; and the hollow like that of a snail-shell the cochlea. They are all channelled out of the substance of the skull-bone before named as the temporal. The part of this bone which lodges them juts inwards, so as to lie at the base of the brain, and is so strong and thick as to be called the petrous or stony part of the bone. Accurately resembling the bony labyrinth in shape, but a little smaller in its dimensions, so as to allow a little liquid to lie between it and the bone, is a membranous labyrinth. That part of the membrane which is on the floor of the vestibule leaves its proximity to the bone at the entrance of the cochlea, and forms a horizontal stage across the widest part of the spiral passage, and so mounts round the three whorls of the spire, dividing it into two parts: so that, if we may imagine a small insect exploring these regions, it could mount to the apex of the spire by either of two spiral staircases, the roof of the lower one being the floor of the upper. These circular staircases only communicate with one another at the point of the shell. The lower one at its foot communicates with the tympanum by the round hole, while the vestibule communicates with the chain of bones by the oval hole. Hence, if our imaginary insect could gain access to the cochlea through the membrane of the round hole, it must first mount to the top of the lower staircase, and then descend all the way down the upper one, before it could explore the labyrinth.

All the cavities are filled with fluid, by whose agency the vibrations are conveyed along their walls; and in these walls, especially at certain parts, are distributed the nerve-fibres of the nerve of hearing. It would seem, however, as though the vibrations of the liquid are not enough to impress the nerve, and there are found small hard structures wherever the nerve-threads are most thickly placed, and at two places in the floor of the vestibule are found collections of small hard marble stones, held in a mesh of fibres; so that, as the waves sweep by in the liquid, these are made to strike and rebound against the nerves. The spiral sheet of membrane which divides the cochlea receives the nerves from a main nerve which runs up the central pillar, and it has in its substance fibrous bars, which radiate outwards at regular intervals, like the key-notes of a piano, and, like these, each is supposed to receive and transmit to the nerve at its root a separate note. Thus the spiral sheet of the cochlea is supposed to be able to appreciate difference in tone, and the labyrinth differences in the amount of sound. The nerves from all parts are collected into one bundle, but, as is usual with nerves wherever they may be found, the strands remain distinct.

To assist the reader in his conception of the ear, we may compare it to a house of business. The pinna is the house-front; the tube is the porch; the drum-membrane the front door (closed); the drum is the hall; a few steps, the ossicles, lead to an office, round which are convenient counters, closets, and passages, at which clerks enter business transactions; while, directly communicating with this large office, cognisant of all proceedings, but reserving to himself any special business, sits the general manager, who has also a door direct to the hall; whilst at the back of the premises telegraph wires run to the London agent.

The external ear of brutes is often so marked a feature in the outline of their bodies, it adds so much grace and finish to the head, its movements give such animation to the gestures, and it is itself an organ so ornamental, that it is almost superfluous to remind the reader that its form and foldings are very various throughout the class Mammalia. Everyone who is alive to the beauties of animated nature—and there are few who are dead to their attractions—must have looked with delight on the ear of the squirrel, with its tassel of soft brown hair. That universal favourite, the rabbit, the dainty little fennec fox, and even the fallow deer, despite the majesty of its horns, would all cut but sorry figures without the external ear.

Among the strangest forms of ears we may mention that of the African elephant, which makes him look like a warrior armed with a double shield. So flat and ample are these ears that Sir Samuel Baker cut a tolerably good mattress out of one of them. The membranous and delicate ear of our larger English bat is proportionately as monstrous, but instead of being flat, its foldings are so decided that it looks like an ear within an ear. The long trumpet-shaped ear of ruminants and horses, capable of being turned in any direction, is admirably suited by its shape, and by the fringe of hair which encircles it, and partially extends across its orifice, to accomplish the double purpose of receiving aërial waves, and excluding any small particles of dust, rain, or hail which would otherwise get down to the sensitive tympanum. This office of protection is, indeed, by no means unimportant, as any foreign body on the drum membrane causes exquisite annoyance, and the steadiest horse will become restive when thus troubled. In the setter and spaniel dogs, the function of protection seems paramount to that of collection of sounds, so that the thick matted ear hangs down, when at rest, right over the orifice of the ear.

It has been remarked, that while the ears of carnivorous animals are directed forwards, those of herbivorous animals are turned backwards; so that, in the pursuit of the latter by the former, the ears of both are so placed as to catch the sound from the object whose movements it is of the highest importance they should be acquainted with. Perhaps this idea has been dwelt on too much, yet everyone must have noticed how the cat, the fox, and the ferret carry their ears pricked forward, while the ears of the deer and hare are at least as readily turned backward as forward. In the case of the hare, however, the shape and direction of the ear seems to be given in relation to the habit it has of crouching in its form. While in its form, the long ears stretch along the flanks, with their orifices turned outward, and must be very efficient in apprehending the sounds which proceed from the feet of man or dog as they beat the stubble.

The concha, or external ear, is very generally found throughout the whole of the class Mammalia, but in a few it is "conspicuous from its absence." Thus two of our native insectivorous mammals, the mole and the shrew, are without it. In the whale and his tribe it is not only absent, but the very foramen which leads to the internal ear in this enormous animal will scarcely admit a pin. Indeed, this entrance to the ear seems to be retained only to establish or strengthen the affinity between the whale and the land mammalia, for the impressions of sound are probably conveyed to the internal ear through the substance of the animal's body, as in the case of fish. The tympanic cavity, however, is kept supplied with air by a eustachian tube that communicates with the passage which runs to the blow-hole near that orifice; so that when the monster discharges the air from the reservoir of its lungs with so forcible a jet that it carries the sea-water before it like a fountain, the air of the tympanic cavity is, at the same time, partially renewed; and when he plunges once more unseen into the depths, this cavity is in communication with the air he carries with him. This arrangement, whereby sound, which has been conveyed from the exterior through the solid structures of the body, is made afterwards to traverse, or to be regenerated in, an internal air cavity, is not uncommon among the denizens of the water, and sometimes it is effected by such singular contrivances, as we shall find when we describe the ear of some fishes, that we are almost justified in supposing that there is some quality in the vibrations of an elastic fluid, like the air, which makes it a better medium for transmitting sound to the nerve fitted to receive such impressions than those inelastic or solid media in which its vibrations are more energetic. This is the more singular, because in no case is air or gas the last substance through which sound passes to the sentient nerve, only it seems desirable that it should be one link in the chain for conveying sound. It is difficult to conceive how the message should be made more distinct by the fact that air carries it for one postal stage in the central part of its course, yet this seems to be the case.

In the case of the whale, the bony sheath of the tympanum is not embedded in the substance of the ear-bone, as in other animals, but hangs below it, and is shaped like a scroll, or like the shell of a volute, or bulla, with a very thick column or inner central part, and a very thin outer lip. By this thin outer margin of the scroll it is attached to the remainder of the ear-bone, but the attachment is so slight that in the dry skull it is easily broken off. In some geological strata this part of the ear-bone is found commonly, while the other bones of the whale are rare; and some attribute this anomaly to the easy severance of the bone, by fracture, from the rest of the skull, just mentioned. It is supposed that from the huge rotting carcase, distended with gas, and beaten about by the waves, the dense tympanic bones may have dropped and been quickly covered by preserving sediment, while the remainder of the animal drifted to shore, and being left to the influence of the atmosphere, left no other vestige behind to attest the presence of these whales in the ancient seas.

We have dwelt thus long on the outer courts of the ear—in the animals that give suck to their young, because the variety displayed in these non-essential parts of the ear is not shown in the parts of the internal or essential ear. All the parts of the internal ear—the semi-circular canals, the vestibule, with its oval hole, and the cochlea—are always present in all mammals. There are, however, some slight differences in the proportion of the parts: thus the so-called circular staircases which mount the cochlea have three and a half turns, or whirls, in the guinea-pig and porcupine, and only one and a half in the whale, and in this last it can scarcely be called a staircase at all, as it does not mount upwards, but curls inwards on the same plane, like the hollow of the shell of the nautilus, instead of that of the trochus or top-shell. There is some variation also in the little chain of bones which spans the drum from the drum membrane to the oval hole; thus the stirrup-bone has no perforation in the lower mammals. These slight differences, however, do not invalidate the statement that the ears of all mammals are made on the same pattern; and if the reader have the patience to accomplish the by no means easy task of dissecting out from its bony case the ear of any such animal, while referring to the description of the human ear, given in the first part of this article, he will be able to identify the several parts, or if he fail to do so, he may search again, for they are all there, though minute and difficult to trace.

The efficiency of the sense of hearing in brutes is a matter of notoriety. Whoever has had the opportunity of watching a herd of wild animals, while unobserved by them, will have been struck with the vigilance with which each unaccustomed sound is remarked. The electric start, by which every individual of the community is thrown at once into an attitude of attention and preparation for a hasty flight, is a beautiful sight. When we remember how many animals are nocturnal in their habits, how many find their home in dense tangled forests, and also how necessary it is that dispersed members of a gregarious tribe, the sexes of wandering species, the helpless young, and protecting dams, should be able to find each other, it is not surprising that this sense is made so wonderfully acute. So much is this sense relied upon for the above-named purposes, that the crafty backwoodsman finds no better expedient for alluring shy game within reach of his rifle than by imitating the call of the species; yet so discriminating are the wild animals that the slightest error in the intonation, or even the frequency, of the cry will send them scampering away from the ambush.

It would seem as though man, who employs this organ so generally in the higher uses of the mind and soul, necessarily sacrifices to these uses some of the acuteness to mere sound of which the ear is capable. The savage starts like the brute when a sound such as the European would scarcely be aware of reaches him from the distant hill; but civilised man, who passes his life amidst the hum of crowded cities, striving rather to abstract his thoughts from intrusive noises, and directing his attention, even when most attentive, to the thoughts that sounds embody rather than to the sounds themselves, is at a disadvantage when brought into contact with the unthinking brute, and he will sometimes pass through scenes teeming with life, and think them inanimate solitudes, because he, the object of dread, has no corresponding acuteness of observation to detect the animals which hide themselves at his approach.

LIGHT.—III.

[*Continued from p.* 180.]

THE REFLECTION OF LIGHT.

REFLECTION OF LIGHT FROM A LOOKING-GLASS.

When the sun is out one may cast a bundle of rays of light about in any direction nearly by facing the sun with a plane mirror in one's hand and slightly varying the inclination of the face of the glass, from which it is apparent that the light of the sun, after falling on the face of the mirror, is sent back. This is termed Reflection.

Try the experiment in sunlight, fixing a perfectly straight darning-needle on to the face of the mirror in a perpendicular position with a bit of wax. Now suppose from where you stand you have sent a bright spot of light on to the side of a building. Consider the position of this spot of light, of the sun, and of the mirror. A line drawn from the sun to the mirror, and thence to the spot on the wall—in other words, the path of the light—makes an angle which the upright darning-needle bisects, or equally divides. Make this angle of incident and reflected sunlight as small or as large as you will, the same thing is always noticed, viz., that the perpendicular drawn from the surface of the glass makes the angle at which the light falls on the glass equal to the angle at which it is reflected. Let *a b* (Fig. 20) represent the perpendicular drawn to the surface of the mirror M, *c b* the direction of the sun's rays falling on it, and *b d* the direction of the reflected rays; then the angle *a b c* is equal to the angle *a b d*, *a b c* is called the angle of incidence, and *a b d* the angle of reflection, and this law is usually expressed by saying that *the angle of incidence is equal to the angle of reflection. Also c b, a b, and d b are always in the same plane.*

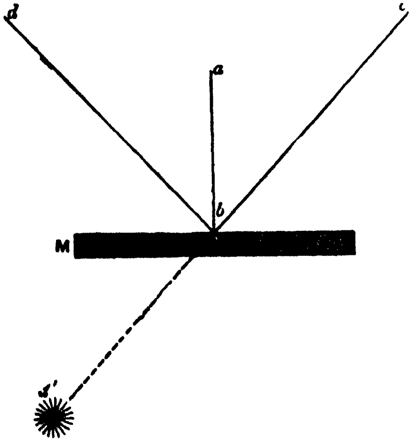

Fig 20.

FORMATION OF AN IMAGE.

Next let M represent a still sheet of water like the surface of a pond. The light of a star falls on its surface, and the eye being placed at *c* sees the image of the star; the path of its incident and reflected rays is therefore represented by the lines *d b*, *b c*. Now when the light from a body enters the eye, it does so in a straight path, and the body, in keeping with past experience, is judged to be at the other end of this straight line. Hence, in this particular instance the light from the star proceeding to the eye in the direction *b c*, the star appears to exist somewhere in that direction, and is seen as if it were at *d′*. We observe an image of the star in the water, apparently behind it, and this image is caused by reflection.

We see bodies which are non-luminous by means of the light which is reflected from their surfaces to the eye; and seeing that non-luminous bodies are visible to us in daylight in every conceivable position, where there is nothing interposing between them and the eye, it follows that light must be reflected from their surfaces in every possible direction, and it is said to be *diffused light.* The light from a piece of white paper is diffused light. Examine the surface of the paper with a lens, and you will find that it is uneven and presents minute reflecting surfaces in every direction.

FORMATION OF THE IMAGE OF A NON-LUMINOUS BODY.

In considering how a reflected image is produced in a looking-glass we are dealing with the reflection of a vast number of points of light or of reflected light in fixed relative positions. Thus, if a boy *c* stand in front of a large mirror A B (Fig. 21), he sees an image of himself standing as it were behind the mirror in the position *c′*. Now take points of reflected light 1, 2, and 3 in fixed relative positions;

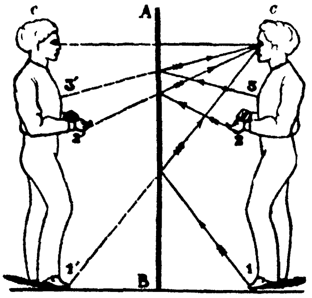

Fig. 21.

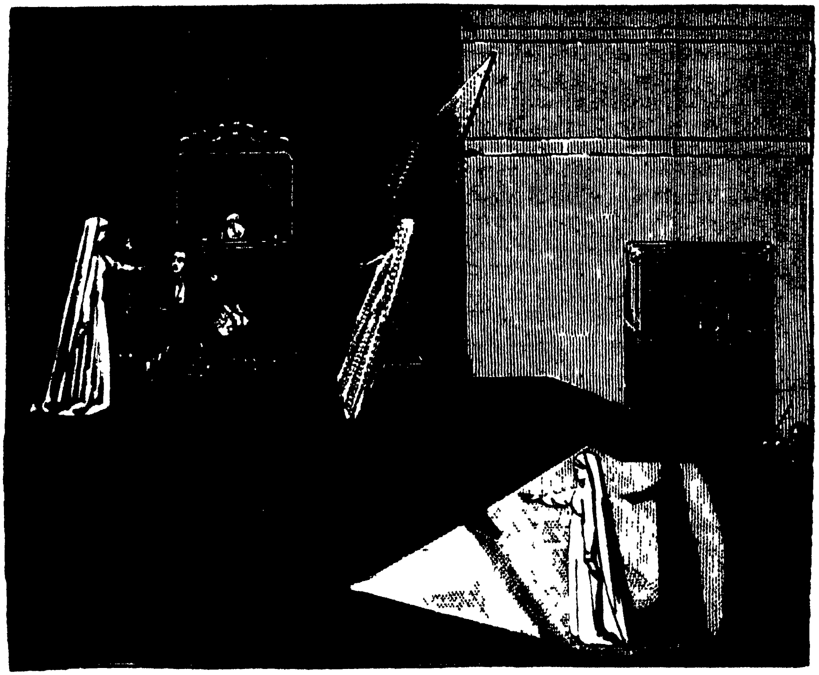

Fig 22.—Pepper's Ghost

they are each reflected from the surface of the glass to the eye of the observer in a direction represented by the arrows, the angle of incidence in each case being equal to the angle of reflection As each reflected ray appears to come from some position beyond the glass the eye locates it there, so that the points of reflected light 1, 2, and 3 appear to have the positions 1′, 2′, and 3′, and an infinite number of reflected points each seen in its virtual position beyond the glass constitute the *virtual* image of the object *c*. A virtual image is an imaginary one which cannot be seen in the air; a real image exists in the air and may be seen when the eye is in a proper position, or may be rendered evident by a screen of white paper.

HOW A STAGE GHOST MAY BE MADE.

There are many practical applications of the laws of reflection, pure and simple, as *e g.*, the production of stage ghosts, and the use of the heliograph, etc. A few words will explain these. Put a candle flame in front of a window pane. You see its reflected image and it appears to be outside, so that a sparrow hopping on the sill may rise and apparently fly through the flame without singeing its feathers. Here you have the secret of the stage ghost (Fig. 22). A large sheet of glass, a magnified window pane, is placed in front of the stage inclined at a suitable angle to the audience, who can see through it all that is enacted behind the footlights. An object placed below and in front of the sheet of glass will be seen by the spectators reflected from its surface and will appear to be on the stage. All necessary precautions are taken for keeping the audience in ignorance of the existence of the reflecting surface, so as to make the illusion complete. The conventional white robes of a ghost lend themselves well to this device, for they reflect a maximum of light, and make an effective virtual image which seems to be behind the invisible and transparent reflector. An actor may walk up to the ghost and run his sword through it, or play any other trick required in the act.

PRINCIPLE OF THE HELIOGRAPH.

The principle of the heliograph is simpler still. The piece of looking-glass mentioned at the commencement of this lesson might be used for reflecting a beam of light on to a distant hill instead of the house side, and there it would appear like a blazing disc, or like the windows of houses seen by the reflected light of the sun. Now, if an object were brought in front of the mirror and only removed for a second the effect to the distant observer would be a flash of light, and the man with the mirror could vary the number of flashes at his pleasure. Hence, with a pre-arranged code of signals, it would be quite easy to convey intelligence to the distant observer, and with a similar arrangement of reflector on his part to receive news from him, even if a hostile force were encamped in the valley between. An arrangement of mirrors for carrying on signalling of this kind with ease and precision constitutes the heliograph, an instrument so often used by us abroad in our little wars where the telegraph has been unavailable.

THE KALEIDOSCOPE

The production of many images from one and the same object is an interesting phenomenon of reflection. Take two small looking-glasses and prop them up on the table at an angle to each other (Fig. 23). Next place a coin on the table between them and look into the glasses; several images of the coin are seen, and the number increases as the angle between the two mirrors is made less and less. It is best to have the two mirrors without frames, and then the number of images observed is found to conform to a very simple law, for it is equal to 360 divided by the angle at which the reflectors are inclined to each other minus one; thus, suppose the glasses make an angle of 45°, then the number of images of the coin will be $\frac{360}{45} - 1 = 7$. By placing the inclined mirrors on a board with the degrees marked out one obtains a multiple image apparatus with which this rule may be

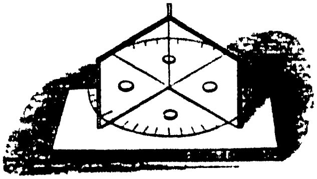

Fig. 23

A modification of this experiment gives us the *Kaleidoscope* (Figs. 24, 25). Two slips of glass AA′, CC′, about eight inches in length, with blackened or silvered backs, are inclined to each other at an angle of 60°, like the looking-glasses in the above experiment. They are put into a tube, where they are held in position at this angle. On to one end of the tube a sort of pill-box end is placed which can be turned round, the bottom of the lid consisting of two circular pieces of glass, *a b*, *c d*, the outer one, *a b*, ground, and the inner one, *c d*, not ground. A few coloured beads are enclosed in the circular box *a b c d*, and as the box is turned round these fragments of glass are for ever changing their positions. The other end of the tube is covered with cardboard with a circular hole in it. On looking through this hole while the circular box at the other end is turned round, one sees a geometrical pattern made up of the coloured pieces of glass, and the design is changed at every turn of the box.

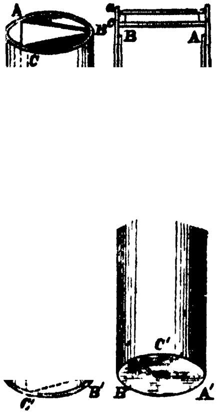

Fig. 24

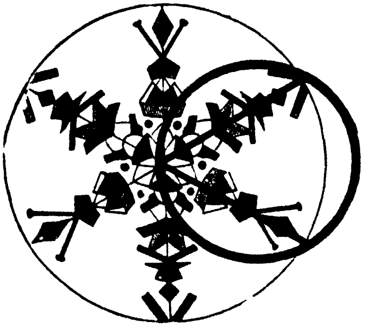

Fig. 25.

REFLECTION FROM CURVED MIRRORS.

Mirrors may be plane or curved. A looking-glass is a plane mirror; and a burnished metal spoon furnishes us with a common illustration of a curved mirror. The back of the spoon is a convex mirror, and the front, or hollow, part is a concave mirror. A little consideration will show that of these curved mirrors there must be many kinds; for there is a great variety of curves.

When the curved mirror forms part of the surface of a sphere we have a spherical mirror, and it may be either concave or convex. The centre of the sphere of which the mirror forms a part is necessarily the *centre of curvature*, and so it is called.

Now let us consider the reflection of light from the surface of a concave spherical mirror. It conforms to the same laws as regulate reflection from a plane mirror; indeed, a spherical mirror may be considered to be made up of an infinite number of minute plane surfaces, to which lines drawn from the centre are perpendicular, and in reflection from these points, or minute planes, the angle of incidence must equal the angle of reflection. Hence, if a ray of light emanate from the centre *c* of a concave spherical mirror, the light will be reflected back to that point (Fig. 26). If two parallel rays *r p* and *r' p'* fall on the mirror, they are reflected in such a manner that the angles of incidence, *r p c* and *r' p' c*, are equal to the angles of reflection, *c p f* and *c p' f*, and the reflected rays meet in *f*. The point *f* is called the focus, and as there may be several foci, this one formed by parallel rays is called the *principal focus*. If, instead of parallel rays falling on the mirror, we had rays emanating from the focus *f*, they would clearly be reflected from the mirror parallel to each other. Suppose, however, the rays come from a point at *f'*, they would clearly be no longer parallel when reflected, but would come together or be *converged* to *d*. If the rays emanate from *c*, then, as we have before stated, they will be reflected back to *c*; and if, finally, we consider the rays of light as emanating from a point nearer the mirror than *f*, then the reflected rays would spread out, as if coming from a point *v* beyond the mirror; in short, they would be *divergent*. The point *v* beyond the mirror is called a *virtual* focus.

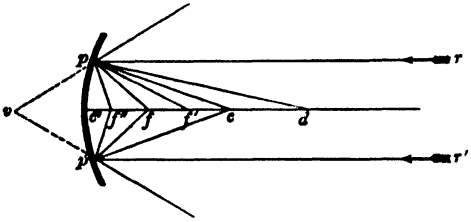

Fig. 26.

THE FORMATION OF IMAGES IN CONCAVE MIRRORS.

If the convex side of a watch-glass be smoked with the flame from burning paper which has been wetted with turpentine, we get a concave mirror which will serve to show the nature of the images formed by it. When the object is at a distance from the mirror equal to the length of the radius of curvature *c c'* (Fig. 27), we see an inverted real image, under suitable circumstances, of the same size as the object; when the object is farther away, we have still an inverted real image, but of a less size. The object may be placed at a less distance from the mirror than *c c'*—as, *e.g.*, between the focus *f* and the centre of curvature *c*—when we get an inverted real image of greater size; whereas if the object be nearer still—as, *e.g.*, between the mirror and the focus *f*—the image is upright, virtual, and of larger size than the object.

Each of these cases may be demonstrated geometrically. Let us take as an example the second case (Fig. 27), where the object A B is farther away than the centre of curvature C. From the point A rays fall on the mirror in every direction. Draw the rays A *b* and A *c'*, and their reflected rays will meet in A', and here we have the image of A. Similarly draw the rays B *b* and B *c'*, they are reflected to B', where we have the image of B. And all intermediate points in A B yield images whose positions are intermediate between A' and B', forming one whole image A' B', real, inverted, and less than A B. By similar methods and reasoning, one might demonstrate geometrically each of the other cases.

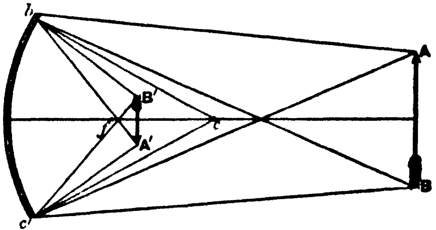

Fig. 27.

THE USES OF REFLECTORS.

The reflection of light is largely made use of for utilising illuminating power. A reflector of concave or convex form for this purpose is a common object in shop windows. The electric searchlight, employed so largely in the Navy, is another example of the use of a concave reflector. Here, however, the curve of the reflector is not a portion of a circle, but of a parabola (Fig. 28). A parabolic mirror, with a luminous source at its focus, is better adapted for reflecting parallel beams of light to a great distance than is the case with a spherical

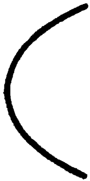

Fig. 28.

mirror. In the searchlight used on board ship a strong electric light is placed in the focus of a parabolic reflector; the rays fall on the mirror, and are reflected outwards in a parallel direction, so that when the searchlight is directed on to an object a distance away there is a concentration of electric light rays on it

THE PHOTOPHONE.

A parabolic reflector is used in the photophone; and this instrument may be explained here, so far as its working depends upon light (Fig. 29). A mirror M reflects sunlight on to another thin glass mirror at D. The glass mirror at D is so thin, that a voice at the mouthpiece O at the back of it throws it into vibration; and, consequently, the rays are reflected in a disturbed state, so to speak, on to the distant parabolic reflector R, where they are converged to the focus P, and received on to selenium forming part of an electric system in which there is the telephone T. At this telephone the observer hears what was spoken at O, although only sunlight has passed between.

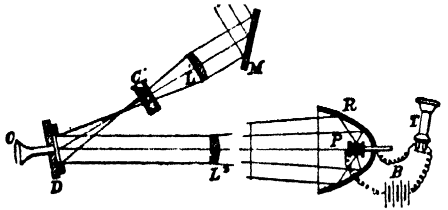

Fig 29

CAUSTIC CURVES.

The observations respecting reflection from a spherical surface only hold true for small portions of such a surface. If light be reflected from a large part of a hollow sphere made into a concave reflector, it is not all brought to one focus, but the rays intersect in many points, which form a luminous curve, spoken of as a caustic curve. A caustic curve may be seen in a very simple manner. Take a glass drinking-vessel, and fill nearly to the top with milk; hold on one side of a light, so that the rays may be reflected from the inner circular surface on to the milk; a caustic curve is seen on the surface of the milk. Or, better still, take a strip of thin polished metal or tin plate, and bend it into a curve; now let it rest on a sheet of white paper, with rays of the sun reflected from the concave surface on to the paper; caustic curves will be seen on the paper, as represented in Fig. 30. This defect unfits spherical mirrors for many purposes, where parabolic mirrors have to be employed instead.

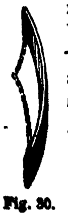

Fig. 30.

SPANISH.—VI.

[Continued from p. 172.]

VOCABULARY.

Abogado,	*lawyer, barrister.*
Ahora,	*now.*
Barato,	*cheap.*
Castigado,	*punished.*
Creado,	*created.*
Créo,	*I believe.*
Diligente,	*diligent.*
Económico,	*economical.*
Escrito,	*written*
Engañado,	*deceived.*
Es preciso, Preciso es,	*it is necessary.*
Feliz,	*fortunate, happy.*
Fiel,	*faithful.*
Frugal,	*frugal.*
Imprudente,	*imprudent.*
Jóven,	*young.*
Lindo,	*pretty.*
Ménos,	*less.*
Negligente,	*negligent.*
Nunca,	*never.*
Ojalá!	*O that! would that!*
Pequeña,	*little, small.*
Pretende	(*he*) *pretends.*
Probable,	*probable.*
Prudente,	*prudent.*
Puede	(*he*) *can,* (*he*) *is able.*
Puntual,	*punctual.*
Quiero,	*I wish.*
Soldado,	*soldier.*

MODEL SENTENCES.

Madrid era pequeña, pero ahora es grande, *Madrid was small, but now is large.*

Es posible que V. no séa premiado, *it is possible that you may not be rewarded.*

Si yo fuese rico, no sería soberbio, *if I were rich, I should not be proud.*

Ne créo que tu séas mas diligente que yo, *I do not believe that thou art more diligent than I.*

Pedro será abogado, *Peter will be a lawyer.*

Siendo como V. es tan negligente, ¿quien le dará á V. libros? *being so negligent as you are, who will give you books?*

EXERCISE 23.

Translate into English:—

1. Soy hijo del juez. 2. Tú eres jóven. 3. ? Soy yo rico? 4. VV. son jóvenes. 5. Pedro es robusto. 6. Este libro es de María. 7. Estos tenedores son de plata. 8. V. es Español. 9. VV. son Alemanes. 10. Somos Españoles. 11. Sois Inglesas. 12. Son Ingleses. 13. Soy Aleman. 14. Es médico. 15. Mis hermanos eran sombrereros, pero ahora son carpinteros. 16. Eras pintor. 17. Yo era abogado. 18. Eran soldados. 19. Éramos zapateros. 20. VV. eran libreros. 21. Ella no era una hermosura. 22. ¿No era yo mas robusto que él? 23. ¿Eran abogados? 24. Erais impresores. 25. El hombre fué creado. 26. Fuimos castigados. 27. Fuiste castigado. 28. VV. fueron premiados. 29. Fuisteis castigados. 30. ¿Fuí premiado? 31. Fuí jóven. 32. He sido desgraciado. 33. Has sido premiado. 34. Hemos sido castigados. 35. Habeis sido fieles. 36. El abogado ha sido desgraciado. 37. He sido feliz. 38. Mi hermana había sido imprudente. 39. Yo había sido castigado. 40. VV. habían sido imprudentes. 41. Serán premiados. 42. Mis hermanos serán abogados. 43. María será una hermosura. 44. Seré médico. 45. Seréis soldados. 46. VV. serán premiados. 47. El vino será barato este año. 48. No séran premiados segun sus obras. 49. Sé bueno. 50. Sed puntuales. 51. Seámos buenos y sábios. 52. Séan las criadas castigadas. 53. Séan VV. felices. 54. Séan los impíos castigados. 55. Séa el impresor premiado. 56. Quiero que mis amigos sean buenos. 57. Quiero que seas feliz. 58. Es posible que no seas pobre. 59. Es (*it is*) posible que Juan no sea castigado.

EXERCISE 24.

Translate into Spanish :—

1. I am a soldier. 2. Thou art a lawyer. 3. They are young. 4. He is diligent. 5. Ye are negligent. 6. She is small and pretty. 7. You (*VV.*) are prudent. 8. Am I imprudent? 9. The spoon is of gold. 10. The ladies are Frenchwomen 11. You (*V.*) are a Spaniard. 12. Ye are Englishwomen. 13. We are Germans. 14. I am an Englishman. 15. She is a Spanish woman. 16. They are shoemakers. 17. Peter was an innkeeper. 18. Thy father was a baker and now is a bookseller. 19. Thou wast a physician. 20. We were shoemakers. 21. Ye were lawyers. 22. You (*V.*) were a judge. 23. They were printers, but now are carpenters. 24. Were^4 not^3 my^1 sisters^2 as culpable as she? 25. I was a general. 26. I was punished 27. This letter was written for my mother. 28 We were punished. 29. They were rewarded. 30. My mother has been unfortunate. 31. Thou hast been rewarded. 32. They have been faithful. 33 I have been punished. 34. She has been beautiful 35. You (*VV.*) have been rewarded. 36. You (*V.*) have been faithful. 37. We had been imprudent. 38. You (*V.*) had been rewarded. 39. Ye had been punished. 40. John will be a soldier. 41. You (*VV.*) will be rewarded. 42. Thou wilt be punished. 43. Peter will be richer than John, but John will be less ignorant than Peter. 44 Flour will be cheap. 45. Never wilt thou be a judge 46. Will^3 the^1 male servants^2 be rewarded? 47. The good shall be rewarded. 48. Be ye faithful. 49. Be thou punctual. 50. May John be as faithful as Peter. 51. May you (*VV.*) be very fortunate. 52. I wish that (*que*) John may be rewarded. 53 I wish that you (*V.*) may be economical. 54. It is very probable that ye may never be rich. 55. It was necessary that they should be punctual. 56 It was necessary that we should not be negligent 57. Would not this bookseller be the better of the two? 58. If I were (*should be*) rich, I would be economical. 59. I do not believe that the physician's mother has (*may have*) ever (*jamás*) been pretty. 60. O that I had (*should have*) been frugal! 61. I wish to be prudent. 62. He who is a bad son cannot be a good father. 63. He pretends not to have been deceived. 64. Being so (*tan*) imprudent as thou art, who will give thee money? 65. O that thou hadst (*shouldst have*) been prudent!

CONJUGATION OF ESTÁR, *TO BE.*

INFINITIVE MOOD.

SIMPLE TENSES.	COMPOUND TENSES.
Present.—Estár, *to be.*	*Past.*—Háber estádo, *to have been.*
Present Gerund. — Estándo, *being.*	*Past Gerund.*—Habiéndo estádo, *having been.*
Past Participle.—Estádo, *been.*	

INDICATIVE MOOD.

	Present.		*Perfect Indefinite.*
Sing.	Estóy, *I am.*	*Sing.*	He estádo, *I have been.*
	Estás		Has estádo.
	Está.		Ha estádo.
	V. esta.		V. ha estádo.
Plur.	Estámos.	*Plur.*	Hémos estádo.
	Estáis.		Habéis estádo.
	Están.		Han estádo.
	VV estan.		VV. han estádo.

	Imperfect		*First Pluperfect.*
Sing.	Estába, *I was.*	*Sing.*	Había estádo, *I had been.*
	Estábas.		Habías estádo.
	Estába.		Había estado.
	V. estaba.		V. había estado.
Plur.	Estabamos.	*Plur.*	Habíamos estádo.
	Estábais.		Habíais estádo.
	Estában.		Habían estádo.
	VV. Estában		VV. habian estádo.

	Perfect Definite		*Second Pluperfect.*
Sing.	Estuve, *I was*	*Sing.*	Húbe estádo, *I had been.*
	Estuvíste		Hubíste estádo.
	Estuvo.		Hubo estádo.
	V. estúvo		V. húbo estádo.
Plur	Estuvímos	*Plur*	Hubímos estádo.
	Estuvisteis		Hubísteis estádo.
	Estuviéron.		Hubiéron estádo.
	VV. estuvieron		VV. hubiéron estádo.

	First Future.		*Second Future.*
Sing.	Estaré, *I shall* or *will be.*	*Sing.*	Habré estádo, *I shall* or *will have been.*
	Estarás.		Habrás estádo.
	Estará.		Habrá estádo.
	V. estará.		V habrá estádo.
Plur	Estarémos.	*Plur.*	Habrémos estado.
	Estaréis.		Habréis estádo.
	Estarán.		Habrán estádo.
	VV. estaran.		VV. habrán estádo.

IMPERATIVE MOOD.

Esté, *let me be*, or *may I be.*
Está, *be thou.*
No estés, *be not.*
Esté, *let him be*, or *may he be.*
Este V., *be you.*
Estémos, *let us be*, or *may we be.*
Estad, *be you* or *ye*
No esteis, *be not.*
Estén, *let them be*, or *may they be.*
Estén VV., *be you.*

SUBJUNCTIVE MOOD.

	Present.		*Perfect Indefinite.*
Sing.	Esté, *I may be*	*Sing.*	Háya estáda, *I may have been.*
	Estés		Háyas estádo.
	Este.		Háya estádo.
	V. esté.		V. háya estádo.
Plur.	Estémos	*Plur*	Háyamos estádo.
	Esteis.		Háyais estádo.
	Estén.		Háyan estádo.
	VV. estén.		VV. háyan estado.

	Imperfect.		*Pluperfect.*
Sing	Estuviéra, estaría, estuviése, *I would, should, might be.*	*Sing.*	Hubiéra, habría, hubiése estádo, *I would, should, might have been.*
	Estuviéras, estarías, estuviéses.		Hubiéras, habrías, hubiéses estádo.
	Estuviéra, estaría, estuviése.		Hubiéra, habría, hubiése estádo.
	V. estuviéra, estaria, estuviése.		V. hubiéra, habría, hubiése estádo.
Plur.	Estuviéramos, estaríamos, estuviésemos.	*Plur.*	Hubiéramos, habríamos, hubiésemos estádo.
	Estuviérais, estaríais, estuviéseis.		Hubiérais, habríais, hubiéseis estádo.
	Estuviéran, estarían, estuviésen.		Hubiéran, habrían, hubiésen estádo.
	VV. estuviéran, estarían, estuviésen.		VV. hubiéran, habrían, hubiésen estádo.

	First Future.		*Second Future.*
Sing.	Si estuviére, *if I should be.*	*Sing.*	Si hubiére estádo, *if I should have been.*
	Si estuviéres.		Si hubiéres estádo.
	Si estuviére.		Si hubiére estádo.
	Si V. estuviére.		Si V. hubiére estádo.
Plur.	Si estuviéremos.	*Plur.*	Si hubiéremos estádo.
	Si estuviéreis.		Si hubiéreis estádo.
	Si estuviéren.		Si hubiéren estádo.
	Si VV. estuviéren.		Si VV. hubiéren estádo.

The different persons of the verb *estar* are generally rendered in English the same as those of the verb *ser*; but in Spanish these verbs are not employed indiscriminately, the one for the other. *Ser* is used to affirm what a person or thing is *naturally* (or *by nature*), as well as *habitual* qualities, or *permanent* or *characteristic* properties of an object. *Estar* is used to affirm *how* anything exists at *any period of time*, or *where* anything exists. Thus the sentences, *la doncella* es *amable*, and *la doncella* está *amable*, would each be rendered in English by "the maid *is* amiable"; but in Spanish the former means "the maid is amiable" naturally or permanently, *i.e.* of an amiable disposition; the latter means "the maid is amiable" for the time being, though her disposition may be far from being amiable. "Mary is in the country" is rendered *María está en el campo*, since *estar* (and not *ser*) is used to affirm *where* a thing is. *Juan es bueno* means "John is good," affirming what John is; *Juan está bueno* means "John is well," *i.e.*, in good health, affirming how John is.

VOCABULARY.

Agrio, *sour.*
Allí, *there.*
Aquí, *here.*
Bueno, *well.*
Caliente, *warm.*
Campo, *country, field.*
Cansado, *weary, tired.*
Ciego, *blind.*
¿ Cómo ? *how ?*
Con, *with.*
Contento, *contented, pleased.*
¿ Cuanto ? *how much ?*
¿ Dónde ? *where ?*
El señor T., *Mr. T.*
Enfadado, *angry.*
Enfermizo, *sickly.*
Enfermo, *sick, ill.*
En casa, *at home.*
Escribiendo, *writing.*
Fonda, *hotel.*
Inglaterra, *England.*
La señora T., *Mrs. T.*
La señorita T., *Miss T.*
Luego, *soon, immediately.*
Média, *stocking.*
Mesa, *table.*
Ocupado, *busy, occupied.*
Pesado, *heavy,*
Plomo, *lead.*
Presente, *present.*
Seda, *silk.*
Sobre, *upon.*
Siempre, *always.*
Triste, *sad, sorrowful.*

MODEL SENTENCES.

¿ Cómo está V. ? Estoy muy bueno. *How are you ? I am very well.*
¿ Dónde está mi libro ? Aquí está. *Where is my book ? Here it is.*

EXERCISE 25.

Translate into English :—

1. El Frances está en la ciudad. 2. Estoy en la calle. 3. Están contentos. 4. Estáis enfadados. 5. Está ocupado. 6. Estás en tu casa. 7. Los abogados están en la fonda. 8. ¿ Estáis cansados ? 9. No estamos cansados. 10. ¿ Dónde está la fonda ? 11. Aquí está. 12. ¿ Dónde está mi sombrero ? 13. Está sobre la mesa. 14. ¿ Está el señor B. en casa ? 15. Está en casa. 16. ¿ Están VV. buenos ? 17. Estamos buenos. 18. Diego está en el campo. 19. Estaba enfermo. 20. Yo estaba contento. 21. Estábamos presentes. 22. Estaban cansados. 23. Estabas enfermo. 24. ¿ No estaba V. en el campo ? 25. ¿ Estuvísteis allí muchos años ? 26. ¿ Estuvieron tristes ? 27. ¿ Estuvo V. mucho[*] tiempo con el juez ? 28. ¿ Cuanto tiempo[†] has estado en Inglaterra ? 29. Nunca hemos estado en Inglaterra. 30. He estado muy enfermo. 31. Juan estará en su casa. 32. Estarán con V. luego. 33. Estarás presente. 34. Estaré con VV. luego. 35. Estemos contentos. 36. Estén presentes. 37. Esté el água caliente. 38. Es posible que estéis presentes. 39. Si Juan estuviese presente, María estuviera contenta. 40. ¡ Ojalá no hubiese yo estado enfermo !

EXERCISE 26.

Translate into Spanish :—

1. We are sad. 2. Ye are angry. 3. He is busy. 4. The water is warm. 5. My father is in the city. 6. The printer is always occupied. 7. Thou art^{2} always^{1} busy. 8. Where is John's book ? 9. Here it is. 10. Where are my spoons, knives, and forks ? 11. Here they are. 12. How are you ? (*how is your worship ?*) 13. I am well. 14. How is Mrs. B. ? 15. She is well. 16. How is Miss B. ? 17. She is not very well. 18. Are you (*V.*) tired ? 19. I am not tired. 20. Is Peter in Madrid ? 21. No, sir, he is in England. 22. The book is upon the table. 23. Mrs. B. was busy. 24. You (*VV.*) were present. 25. Ye were present. 26. Was not my father in the city ? 27. We were in the street. 28. Thou wast with thy friend. 29. I was (perf. def.) sad two years. 30. Wast thou there ? 31. Was he there ? 32. I have never been in England. 33. We had been very sick. 34. I shall be busy. 35. We shall be in our houses. 36. Ye will be present. 37. Peter will be with us immediately. 38. Be ye contented. 39. May he be contented. 40. It is possible that Peter may be in his house. 41. It is probable that the lawyers may be tired. 42. O that you (*V.*) had (*might have*) been present ! 43. The^{3} judge^{4} being^{1} ill^{2}, gave his money to his sons.

The student can proceed to write and re-write all the parts of the verb *estar*, continuing the practice till he has committed it to memory, and afterwards translate the following exercise on *ser* and *estar*.

EXERCISE 27.

Translate into Spanish :—

1. Thou art proud. 2. Thou art angry. 3. Death is terrible. 4. We are in the street. 5. My

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[*] *Mucho tiempo*, much time, equivalent to *long time* or a *great while* in English.

[†] *Cuanto tiempo*, how much time, meaning *how long*.

father is very rich. 6. My mother is very sorrowful. 7. Lead is heavy. 8. The milk is sour. 9. I am a German. 10. We are imprudent. 11. We are ill. 12. She is old. 13. She is contented. 14. My mother is blind. 15. My daughter is blind with (*de*) anger (*ira*). 16. Mary is beautiful. 17. Lucy is busy. 18. John is good. 19. John is well. 20. The spoon is of gold. 21. The spoon is upon the table. 22. The stockings are of silk. 23. The stockings are in the street. 24. The book is for Mary. 25. The book is in the hotel. 26. Here are the stockings. 27 My mother is sickly. 28. My mother is sick. 29. The buttons are silver. 30. They are writing. 31. Sugar is sweet. 32. They are wise. 33. They are sorrowful. 34. Where is my hat? 35. Here it is.

CONJUGATION OF *TENÉR*,[*] *to have.*

INFINITIVE MOOD.

SIMPLE TENSES.	COMPOUND TENSES.
Present.—Tenér, *to have.*	*Past.*—Habér tenído, *to have had*
Present Gerund. — Teniéndo, *having.*	*Past Gerund.*—Habiéndo tenído, *having had.*
Past Participle.—Tenído, *had.*	

INDICATIVE MOOD.

	Present.		*Perfect Indefinite*
Sing.	Téngo, *I have.*	*Sing*	He tenído, *I have had.*
	Tiénes.		Has tenido
	Tiéne		Ha tenido.
	V. tiéne		V ha tenido
Plur.	Tenémos	*Plur*	Hémos tenido.
	Tenéis		Habéis tenido.
	Tiénen		Han tenído
	VV. tiénen		VV. han tenído

	Imperfect.		*First Pluperfect*
Sing.	Tenía, *I had*	*Sing*	Había tenido, *I had had*
	Tenías.		Habías tenído.
	Tenía		Había tenído.
	V. tenía.		V. había tenido
Plur.	Teníamos.	*Plur*	Habíamos tenído
	Teníais.		Habíais tenído
	Tenían.		Habían tenído
	VV tenían.		VV habían tenido

	Perfect Definite.		*Second Pluperfect.*
Sing.	Tuve, *I had.*	*Sing*	Húbe tenído, *I had had.*
	Tuviste.		Hubiste tenído.
	Túvo.		Húbo tenído
	V. túvo		V húbo tenido.
Plur.	Tuvímos.	*Plur*	Hubímos tenído
	Tuvísteis.		Hubísteis tenído
	Tuviéron.		Hubieron tenido.
	VV. tuviéron.		VV hubiéron tenido.

	First Future.		*Second Future.*
Sing.	Tendré, *I shall* or *will have.*	*Sing*	Habré tenído, *I shall* or *will have had.*
	Tendrás.		Habrás tenído.
	Tendrá.		Habrá tenído.
	V. tendrá.		V. habrá tenído
Plur.	Tendrémos.	*Plur.*	Habrémos tenído.
	Tendréis.		Habréis tenído.
	Tendrán.		Habrán tenído
	VV. tendrán.		VV. habrán tenído.

IMPERATIVE MOOD.

Sing. Ténga, *let me have*, or *may I have.*
Ten, *have thou.*
No téngas, *have not.*
Ténga, *let him have*, or *may he have.*
Sing. Ténga V., *have you.*
Plur. Tengámos, *let us have*, or *may we have.*
Tenéd, *have you*, or *ye.*
No tengáis, *have not.*
Téngan, *let them have*, or *may they have.*
Téngan VV., *have you.*

SUBJUNCTIVE MOOD.

	Present.		*Perfect Indefinite.*
Sing.	Ténga, *I may have.*	*Sing.*	Háya tenido, *I may have had.*
	Téngas.		Háyas tenído.
	Ténga.		Háya tenído.
	V. ténga.		V. háya tenído.
Plur.	Tengámos.	*Plur.*	Háyamos tenído.
	Tengáis.		Háyais tenído.
	Téngan		Háyan tenído.
	VV. téngan.		VV. háyan tenído.

	Imperfect.		*Pluperfect.*
Sing.	Tuviéra, tendría, *or* tuviese, *I would, should, or might have.*	*Sing.*	Hubiéra, habría, *or* hubiése tenído, *I would, should*, or *might have had.*
	Tuviéras, tendrías, *or* tuviéses.		Hubiéras, habrías, *or* hubiéses tenído.
	Tuviéra, tendría, *or* tuviése.		Hubiéra, habría, *or* hubiése tenído.
	V. tuviéra, tendría, *or* tuviése.		V hubiéra, habría, *or* hubiése tenído.
Plur.	Tuviéramos, tendríamos, *or* tuviésemos.	*Plur.*	Hubiéramos, habríamos, *or* hubiésemos tenído.
	Tuviérais, tendríais, *or* tuvieseis		Hubiérais, habríais, *or* hubiéseis tenído.
	Tuviéran, tendrían, *or* tuviesen.		Hubiéran, habrían, *or* hubiésen tenido.
	VV tuvieran, tendrían, *or* tuviesen		VV hubiéran, habrían, *or* hubiésen tenído.

	First Future		*Second Future.*
Sing	Si tuviére, *if I should have.*	*Sing.*	Si hubiére tenído, *if I should have had.*
	Si tuviéres.		Si hubiéres tenído.
	Si tuviére		Si hubiére tenído.
	Si V tuviere		Si V. hubiére tenído.
Plur.	Si tuviéremos.	*Plur*	Si hubiéremos tenído.
	Si tuviéreis		Si hubiéreis tenído.
	Si tuviéren		Si hubiéren tenído.
	Si VV. tuviéren.		Si VV. hubiéren tenído.

VOCABULARY.

Aceite, *oil.*
Ayer, *yesterday.*
Bota, *boot.*
Calentura, *fever.*
Calor, *heat.*
Es estraño, *it is strange.*
Frio, *cold, coldness.*
Hierro, *iron.*
Manzana, *apple.*
Marmol, *marble.*
Memória, *memory.*
Miel, *honey.*
Nuez, *nut.*
Paciencia, *patience.*
Pera, *pear.*
Silla, *chair.*
Sopa, *soup.*
Suceso, *success.*
Temor, *fear.*
Vergüenza, *shame.*

MODEL SENTENCES.

Esa muger no tiene vergüenza, *that woman has not shame* (i.e., *is not ashamed*).
Juan tiene calor, *John has heat* (i.e., *John is hot*).
Tenga Pedro dinero, *let Peter have money.*

EXERCISE 28.

Translate into English:—

1. ¿Tiene V manzanas? 2. Tengo manzanas. 3. VV. tienen sillas. 4. Tenemos calor. 5. Tienen vergüenza. 6. ¿Tengo yo vergüenza? 7. Tienes vergüenza. 8. ¿Quienes tienen peras? 9. Mis hermanos tienen hierro. 10. Tenemos tenedores. 11. Tienes cuchillos. 12. ¿Que especie de azúcar tiene el aldeano? 13. Ella no tiene marido. 14. Tenemos una casa. 15. ¿Tenemos mesas? 16. ¿Tienes candeleros? 17. La rosa tiene espinas. 18. V. tiene memória. 19. ¿Tienen VV. sopa? 20. Tenemos

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[*] *Tenér* is seldom used as an auxiliary verb, and *habér* is seldom used as a transitive verb. Thus, "I *have* money" would be *tengo dinero*; and "I *have* spoken," *he hablado*.

suceso. 21. El médico tenía confianza en la Española. 22. Ella no tenía lámpara. 23. Yo tenía una rosa. 24. Tenían dinero. 25. V. tenía una média. 26. Teníais plata. 27. Tenías oro. 28. Ella tenía prudencia. 29. ¿Tenía yo zapatos? 30. ¿No tenían mesas? 31. Tuvo azúcar ayer. 32. Tuve botones ayer. 33. Ella tuvo harina ayer. 34. Tuvísteis dinero. 35. Tuvimos lamparas. 36. Tuviste candeleros. 37. No tuvieron espejos. 38. ¿Tuviste una pluma? 39. Tuve una casa. 40. Tuvimos medias de seda ayer. 41. Ella ha tenido dos maridos. 42. Han tenido muchos cuidados. 43. Yo no había tenido sopa. 44. Tendrán aceite. 45. V. tendrá hambre. 46. Tendrán vergüenza. 47. Habré tenido dinero. 48. Ten paz con todos los hijos del médico. 49. Tengan miel. 50. Tengamos espejos. 51. Tenga V. confianza en él. 52. Es posible que tengas aceite. 53. Quiero que María tenga dinero. 54. Probable es que tengamos algun mérito. 55. Quiero que VV. tengan candeleros. 56. No era estraño que yo tuviese dinero. 57. Era preciso que no tuviésemos azúcar. 58. Juan tendría un tenedor. 59. ¡Ojalá yo no hubiera tenido estas lámparas! 60. Si yo tuviere paciencia, tendré suceso.

EXERCISE 29.

Translate into Spanish:—

1. They have pears. 2. We have pens. 3. She is hungry. 4. I am thirsty. 5. I am afraid. 6. We are cold. 7. Ye have a lamp. 8. Who has nuts? 9. Ye have looking-glasses. 10. What sort of buttons have you (*V.*)? 11. Have we marble? 12. I have three sons and two daughters. 13. Ye have three brothers. 14. Mary has much confidence in the judge. 15. We were (imperf.) hungry. 16. You (*VV.*) had (imperf.) confidence in my brother. 17. Had (imperf.) we boots? 18. They had butter yesterday. 19. We had a fever yesterday. 20. Ye had chairs yesterday. 21. The shoemaker has had much care. 22. I have had much iron. 23. Thou hast had three daughters. 24. We have had two sons. 25. Mary has had a fever. 26. Ye have had much money. 27. I shall have a candlestick. 28. She will have a fork. 29. Thou wilt be hot. 30. We shall be thirsty. 31. Have ye peace with all men. 32. Let him have pens. 33. Let them have honey. 34. I wish that my mother may have flour. 35. It is probable that they may have lamps. 36. I wish that I may have silk stockings. 37. It is possible that ye may be hungry. 38. It was (*era*) not strange that they should have pears. 39. It was strange that you (*V.*) should have oil. 40. If thou shouldst have boots, I would have shoes. 41. I do not believe that Peter has (say, *may have*) had butter. 42. Oh that they had not had those books! 43. If my sons have (say, *shall have*) patience, they will have success.

The student can now write all the persons of the tenses of the verb ***tenér***, as he has been already directed with regard to previous verbs.

COMPARATIVE ANATOMY.—VIII.

[*Continued from p. 198.*]

ARACHNIDA (*continued*).

THE mandibles spring from under the truncated front of the shield, and are directed downwards. They have two joints, the thick descending basal piece having attached to the outer part of its end a hooked claw, which works on a joint, so that the point of it can play from the side towards its fellow on the other side. When the claw is completely flexed, it lies in a groove which runs along the far edge of the rear joint. This groove has its two walls generally armed with points or teeth. The maxillæ, or under-jaws, consist of two plates, the inner edges of which can be approximated or removed from one another. Their edges and upper surfaces are often studded with small spines. From the base and outside of these plates arise the long-jointed palps, which in the female end in claws like the legs. In the male a very complex organ is found, which can be doubled up into a rounded fist, and by this the adult male can be readily distinguished from the female. The lower lip, or labrum, is of various shapes, but usually quadrate. The legs are seven-jointed. The first joint is called the coxa, or haunch; the second, the trochanter; the third, the femur. These last two form the thigh, and to this point the legs are like those of insects. The tibia, or shank, which is whole in the insect, is in spiders of two pieces; while the foot, instead of being in five small bead-like joints, is of two pieces only, and they are of the same thickness as the joints which precede them. The last joint has two, three, or more movable curved claws which are often toothed like a comb. On the under side of both joints there are sometimes found pads, hairs, or spines, which can be opposed to the claws, and so form an effective hand for weaving.

The abdomen is a globular or oval bag. It often overhangs the thorax in front. Its walls are very flexible and elastic, as is necessary, in that at certain seasons it is distended with eggs. It contains the major part of the fat and liver masses, the organs of generation, and the web-secreting glands. It is attached to the front segment by a very narrow stalk. Through this thin stalk, however, prolongations of almost all the organs of the body are carried. Thus the alimentary canal and the small hinder continuation of the nervous cord pass from the cephalo-thorax to the abdomen, and the blood-system is continued forward from the latter to the former. If the spider be placed on its back, two plates, with a slit on the inner side of each of them, will be seen. These plates cover the breathing cavities. Between them is the opening of the generative organs. The anus is at the extreme end of the abdomen, and immediately below it are the palp-like jointed protuberances through which the silk of the web is forced or drawn. These are in three or four pairs, and they are perforated at the ends with many small pores, to a number estimated at 1,000. We trust the reader has now a pretty clear idea of the outer form of the spider; and he cannot do better than verify the description by catching a spider, killing it in hot water, and then examining it with a Coddington lens.

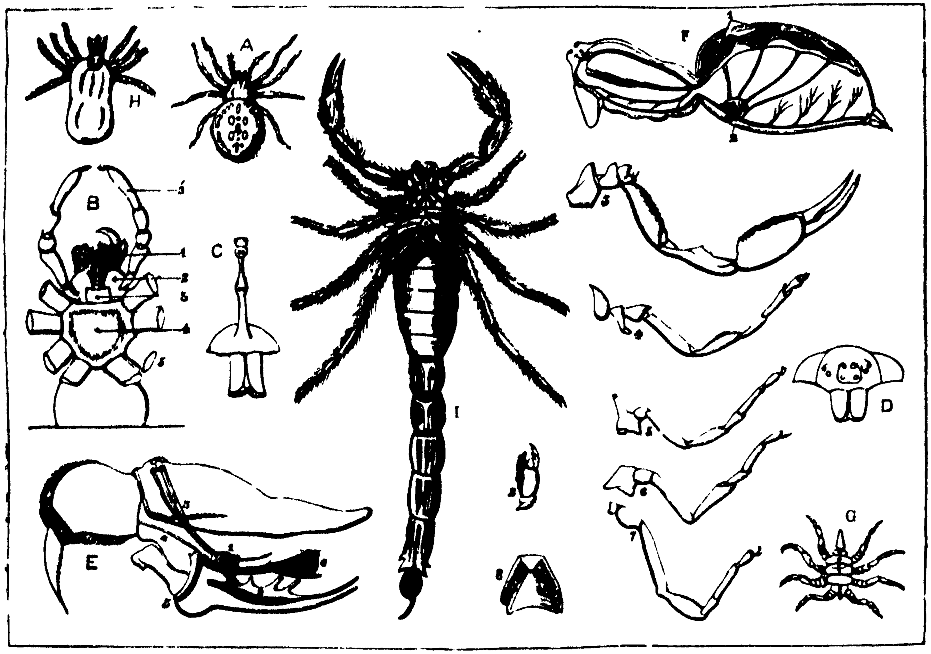
We proceed to describe the internal organs in detail. The mouth, situated between the jaws, leads to a throat which runs a short way backward, then bends sharply upward, and then again backward, in a horizontal position. From the outside of this last-named flexible horizontal portion, which opens into a globular stomach behind, muscles run to the inner wall of the shield, and thus provide the means of sucking up juices. The lower oval and depressed portion of the stomach sends from each of its sides five tubes, which bend upwards, and then enter an annular second stomach, which is situated above the other. A solid mass lies between the stomachs, and to this a muscle is attached, which passes through the central hole of the upper ring-like portion, to be attached to the dorsal shield above. This muscle not only suspends the stomach, but, by contracting and relaxing, causes the lower sac to work like a bellows, and so stirs its contents, driving them through the side tubes into the upper stomach, and this favours the functions of digestion and absorption. Almost the whole nutritive process is carried on in the stomach, for only a narrow prolongation of it is carried into the abdomen. Just before the exit, the intestine dilates into a roundish cavity, which is called the cloaca, and receives two ducts, one on each side, which are the excreting organs to remove the nitrogenous products of the breaking down of the tissues of the body. The ducts, three or four in number on each side, which enter the abdominal portion of the alimentary canal, proceed from the large masses of fatty substance which is collected into a mass of vesicles on either side of the bag-like hind segment. This arrangement would seem to be necessary on account of the precarious nature of the supply of food. These creatures, having to lie in wait for their prey, must be able to play a waiting game; and they manifest, by their fierceness when a stray victim falls into their toils, that they appreciate an opportunity which may be long before it is repeated.

The heart lies immediately under the skin of the back of the abdomen. It is divided into four chambers, placed in a longitudinal series, and propels the blood forwards. It is contained in a loose membranous investment, which is called the pericardium. This is a reservoir for the blood received from the system, and it passes from this outer court of the heart into its four compartments, through small valvular holes, one to each compartment. The large vessel given off in front passes into the cephalo-thorax, and there divides into three pairs of vessels. The top pair goes to the eyes and mouth organs, the middle pair to the stomach, and the lowest pair to the legs. The blood from these is collected again, and flows through a long central vessel running along the floor of the body right to the spinnerets, giving off vessels to the skin and viscera, and also sending part of its supply of blood to the pulmonary sacs. After being distributed through the lungs, the blood is collected into a number of vessels which run from these along the sides of the body, mounting upwards, and discharging themselves into the pericardium. The lung-bags contain a number of fine leaves which lie close together like the leaves of a book, and in these the blood is aërated.

The nervous system in the spider is remarkably concentrated. A small double ganglion rests on the top of the throat, and sends cords to the eyes and jaws. This is connected by two cords, one on each side of the throat, to a large nervous star-shaped mass, which lies on the floor of the cephalo-thorax, and sends nerves to the legs, while from its hind part a thicker cord passes into the abdomen, and there splits into a number of small nerves which go to all parts of the viscera. The great star-shaped mass represents the whole chain of double ganglions, shortened, and compressed into one. It will be seen that this arrangement is very much like that of the nervous system of the short-tailed Crustacea, or crabs.

The glands of special secretion are of two kinds. The poison-glands lie in the cephalo-thorax, one on each side of the throat, and in the upper part of the mandibles. A duct from each gland passes to the point of the fang, and conveys a liquid which acts as a rapid poison to insects.

The silk-secreting organs found in the abdomen consist of a great number of tubes, on which rounded clusters of follicles are found. These have also dilatations in their course. All the tubes end in the spinneret, and the substance they secrete is a sticky liquid which is squeezed through the open pores at the ends of the external organs. It would i that not only all the threads of each spinneret over foliage, etc., that communicate with tubes in which the spider lies concealed. The *Linyphiidæ* spin horizontal webs, and stand clinging to their



ig. 28.—A. Epeira Quadrata, a common British spider. B. Under side of cephalo-thorax of Agelena. C. Front of cephalo-thorax of Walckenaëra Acuminata, with its eyes mounted on a watch tower. D Ditto of Epeira. E. Cephalo-thorax of Mygale, showing the relation of the nervous and alimentary systems. F. Diagram of Section of Spider, showing its blood-vascular system. G. Pycnogonium Littorale. H. Ixodes (Dog-tick). I. Scorpion.

Ref. to Nos. in Figs.—B 1, mandible, or antennary jaw; 2, maxilla; 2′, its palp; 3, labrum; 4, breastplate; 5, origin of legs. E. 1, brain; 2, thoracic ganglion with the cut ends of the nerves of the legs; 3, optic nerves; 4, mandibular nerves; 5, mouth; 6, commencement of stomach. F. 1, Four-chambered heart; 2, lung. I. 2, mandible; 3, maxilla, with its pincer-like palp; 4, 5, 6, 6, legs; 8, comb-like organs on the sternum of the tenth segment

run together, but that all the strands so formed from all the spinnerets are united into one cord. As the thread is evolved, the spider usually grasps it with its two hind feet, which may either consolidate it or draw it out. The sticky secretion of the web dries on exposure to the air.

All the spiders appear to be silk-spinners, but they do not all apply their arts to the fabrication of snares. Fully one-half of them confine their weaving to the construction of cocoons for their eggs, or for lining or making tubes and tunnels into which they can retreat. The little Salticus, which, dressed in a harlequin suit, courses over the upright walls that the hot summer sun shines upon, springs on its prey, first securing itself by a thread lest it should fall. Those spiders which spin snares do so according to very different methods. The *Agelenidæ* spin loose, irregular webs under sides, back downwards. The chief of all spinners are the *Epeiridæ*. These spin vertical webs whose lines are all in one plane. The outer framework of these webs is necessarily irregular, because this is determined by the support on which it rests, but all within this is beautifully symmetrical. Lines radiating from a common centre pass to the cords of the frame, and on these is sustained a close-set spiral line, which runs continuously from centre to circumference, being attached to each radius as it passes them. These lines are very elastic, and will bear a good deal of strain. It is a peculiarity of these lines that they have on them, at regular intervals, beads of viscid matter, which does not dry in the air like the silk. A clew runs from the web to the neighbouring retreat where the spider hides; and this would seem to answer the double purpose of informing the spider when the snare is shaken by an entangled insect, and of affording it a way whereby at once to rush upon its victim. When the insect is powerful, the spider will wait till both ends of the body are attached to the web, and then, striding over it, it will hold the cords of attachment tense with its wide hind-legs, touch the insect with its spinnerets, fix a thread to it, and then set it rapidly revolving with its fore legs, until the insect is completely enswathed in silk, like a mummy. The watch-box of the spider is usually under some leaf, but often it constructs a dome of silk to protect it from the rain, etc. A most remarkable instance of an animal formed for air-breathing, all of whose relatives live in air, having invaded the water, is found in the *Argyroneta aquatica*, which makes a dome under water, and then carries down air, which it places under its diving-bell.

The scorpion is the type of another group of Arachnida. This creature is much more elongated than the spider, and its segmentation is very much more distinct, the segmentation of the abdomen furnishing its distinguishing characteristic. The thoracic shield, which is supposed to represent the dorsal half, is of eight rings. About the centre of this are seen two eyes, one on each side, and close to the mid-line, while at the front outer angles groups of simple eyes are found. All the jaws and limbs are supposed to belong to these coalesced segments. The succeeding segments of the back are as wide as the cephalo-thorax, while the remaining six are very narrow, and capable of moving on one another by definite joints in an up-and-down direction. The last segment has a hooked spine with its point directed downwards. This is the instrument of attack, and it contains a gland from which poison is ejected in the wound it makes. Thus the sting, instead of being in the antennal jaw at the head end, as in the spider, is placed in the very hind-joint of the scorpion. The bases of the legs almost obliterate the under segments or sterna of the fore part of the body, but the succeeding ones are well represented, and through four of them the slits which lead into the eight lungs are cut. Between the black horny back and front pieces of these segments is a white flexible membrane. In the six tail-pieces the top and bottom parts are united immovably together. The nature of the limbs is best seen in the illustration (Fig. 28). The small forceps in front would seem to correspond with the mandibles of spiders, and the large and long pincers to the maxillary palps, while the four pairs of succeeding legs represent the legs of spiders and the hind walking-legs of decapod crustaceans. Thus it would appear that the hind foot-jaws and first pair of walking-legs of crustaceans are absent. The stomach in the scorpion is much simpler than in the spider, and there is scarcely any distinction of parts. The heart has eight segments, and the hind one, not being situated farther back than the broad part of the body, sends the blood backward by a vessel to the tail. Besides the ventral vessel, a sub-ganglionic vessel exists, which drives the blood to the lungs. The course of the blood may be seen from the rough diagram below (Fig. 29). The nervous system consists of seven double ganglia besides the brain.

The mites have a smooth bag-like body, with a small head united with it. They breathe through tracheæ, whose entrance-orifices are situated on the under side of the body. Some, however, have two exit-holes for the tracheal system, one on each side of the mouth, through which they expel the air derived through the other openings. These creatures often live on the bodies of other animals. The shard beetle has almost always a multitude of them clinging to its body in the grooves between the segments of its body underneath. The organs of the mouth in these are usually converted into sucking snouts, with points directed outwards, so as to secure the hold of the creature.

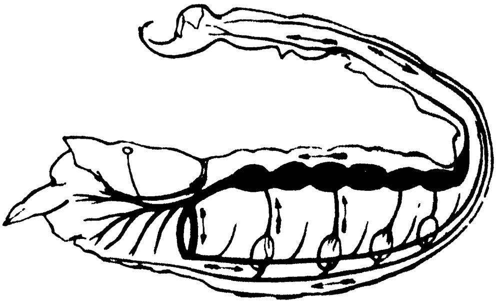


Fig. 29.—Blood-Vascular System of Scorpion.

There are two other orders of very low grade. In one of these the body is completely like a worm. These are internal parasites. The other order is represented by a creature which inhabits the skin-follicles of the human face, generally fixing on the nose as its habitat. This starts in life with a worm-like form, and gradually shortens into a mite-like animal. The orders are defined as follows:—

1. *Pantopoda.*—Arachnida, with the cephalo-thorax segmented into four pieces; a rudimentary abdomen, and long many-jointed legs; without true organs of respiration.

2. *Linguatulina.*—Wormlike Arachnida, having the habits of intestinal worms; with sexes distinct, and no apparent organs of respiration.

3. *Tardigrada.*—Hermaphrodite Arachnida, with stumpy legs, and without organs of respiration.

4. *Acarina.*—Arachnida, with biting or sucking mouths; an unjointed abdomen united to the cephalo-thorax; second feeler-jaws foot-shaped; with a tracheal system.

5. *Araneina.*—Arachnida, with biting jaws, stalked unsegmented abdomen; second pair of feeler-jaws shaped like feet, and with combined lungs and tracheæ.

6. *Arthrogastra.*—Arachnida, with a distinctly jointed abdomen, breathing by lungs.

MYRIOPODA.

The Myriopoda, or Centipedes, are forms with elongated bodies on which there are a number of appendages similar in character to one another. In front of the head there is one pair of feelers, and three pairs of feet are modified to form foot-jaws. One of the orders of the class is remarkable for having two pairs of appendages on all but the more anterior segments of the body. They are known as the Chilognatha, and Julus may be cited as an example.

The other order has the Scolopendra for its type. The transverse section of this animal is of oblong form, and exhibits a flattened structure; the broad horny back and belly plates are joined to one another on each side by leathery side-pieces, on which the limbs are set, and the breathing-holes open. The jaws of this creature are most formidable, and a poison-bag within the body sends a very noxious secretion by a duct to the end of the fang. These creatures are carnivorous, and rapid in their movements, and their generative organs open at the end of the body, being in this respect, as in all others, more like the insects than the *Julidæ*. Peripatus is still more wormlike than any Myriopod. The limbs are only imperfectly jointed, the tracheæ are much simpler and shorter, and the renal organs are of the annulate type. It has a wide geographical distribution, being found in the West Indies, the more northern parts of South America, South Africa, Queensland, and New Zealand. This wide distribution, added to its anatomical characters, indicates that it is a very ancient form, and it has been made the representative of a special group—the Protracheata, or ancestors of Arthropods with tracheæ.

INSECTA.

In Insecta, as in Crustacea or Arachnida, there are forms whose simplicity of organism and general inferiority of structure make the comparison of them with the highest members of the other groups, with any idea of rivalry, absurd. Each class, too, culminates in organisms whose varied parts and elaborateness of detail seem to place them at an elevation beyond which it seems impossible to mount. In many respects, as in their respiratory and circulatory systems, the spiders seem to show an advance upon the Insecta; while their larger size and the greater complexity of their nutritive organs claim for the Crustaceans a certain kind of superiority for them; but we find in the class Insecta the greatest development of those peculiar excellences for which the whole articulate branch is noted. The great characteristic of the Articulates is their external skeleton, and the adaptation of this to the purposes of locomotion is, so to speak, the aim of this sub-kingdom. Other organs and systems of organs are elaborated in an unsteady and fluctuating manner, sometimes appearing to be degraded, or altogether altering their type, as we proceed from one order to another; but the perfection of the external investment, and its better adaptation to the most efficient kind of locomotion, is seen in every upward step we make in our classification. And it is in the class Insecta we find such marvellous finish and efficiency in this part of the organism as to fill not only the naturalist, but even the casual observer, with wonder. The strength and beauty of the elegant body and sculptured limbs—the delicacy and yet the power of the wings—the splendour of the colours, and elaborateness of pattern, whether expressed in these gorgeous hues, or markings and chasings—are all so exquisite that the class is a general favourite with all. As if to exhibit how unlimited may be the variety while the ground-plan is the same, we find a greater number of species in this class than in all the rest put together. One order of insects, the Coleoptera, has not less than 80,000 different kinds known to, and already described by, naturalists, and yet so imperfectly has the search for these hiding and burrowing insects been carried out that it would not be a matter of surprise if a few years should double the number of known species.

The reader must have seen insects so often that it seems superfluous to describe their general form and constant peculiarities; yet we are so often accustomed to see without examining, and to examine without noting, that perhaps the fact that a fly or a gnat has six legs may be new to some persons who have been plagued by these creatures all their summers. The body, then, of a typical insect in its final and perfect state consists of three well-defined divisions, called (beginning from the front) the head, the thorax (chest), and abdomen. So deep is the notch which divides them from one another, and so small is the stalk or connection which unites them in bees and flies, that the divisions of the bodies of these insects cannot have escaped notice. In beetles and butterflies, the divisions, though not quite so marked, are evident enough, but in such insects as crickets and plant-bugs they are traced with some difficulty. To the head is deputed the faculty of sensation and prehension; to the thorax the office of locomotion; while almost all the functions of organic life, such as digestion and reproduction, are delegated to the abdomen. The head is variously shaped, commonly resembling a disc, and presenting a flattened but still convex surface forwards, on the expanse of which are situated two antennæ or feelers. These are almost constantly present, but their form is so modified in different insects that no general description can be given of them. Usually they are jointed, but the number of the joints, their relation, size, and shape, and all connected with them, are so different in different families, that they often form an important means of distinguishing one family from the other. The mouth opens on the bottom part of the edge of the disc, while the large complex eyes cover the lateral edges, and extend often both in front and to the middle line at the top of the head. The organs which, standing round the mouth, minister to all the accessory

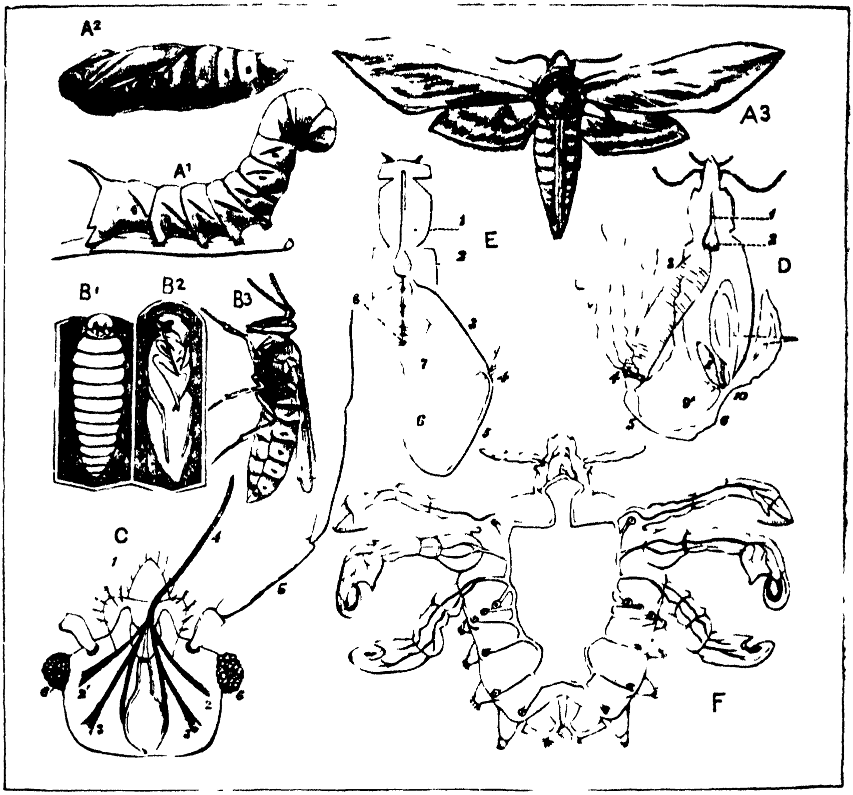


Fig. 80.—A, Privet Hawk Moth (Sphinx Ligustri); A^1, Caterpillar; A^2, Pupa. A^3, Imago B, Common Wasp (Vespa); B^1, Larva, B^2, Pupa, B^3, Imago C, Under side of Head of Bed bug (Cimex Lectularius), with lower Lip removed (much magnified) D, Beetle with Dorsal Integuments removed to show Viscera. E, Bee. F, Parasitical Insect seen by transmitted light, and highly magnified to show Tracheal System.

Refs. to Nos in Figs.—C, 1, labrum, or upper lip; 2, 2′, roots of the mandibles; 3, 3′ roots of the maxillæ; 4, mandibles and maxillæ combined into a piercer; 5, antennæ, 6, 6′, eyes D, 1, œsophagus, 2, gizzard; 3, stomach; 4, entrance to the secreting organs; 5, small intestine; 6, large intestine, 7, ovaries; 8, spermatheca; 9, accessory glands; 10, common cloaca. E, 1, œsophagus; 2, crop, 3, stomach; 4, entrance of the secreting organs; 5, small intestine; 6, large intestine; 7, common cloaca; 8, ganglionic chain functions of gaining and swallowing food, have, though very diverse in shape, been harmonised by the labours of entomologists so as to represent one plan. There is in front the labrum, or upper lip, then two pairs of jaws, one pair behind the other, but each single jaw playing from the side to meet its fellow in the mid-line. Behind these is the under lip, which is sometimes very complex, being split into three or five divisions. When the mouth organs are spoken of as lips and lateral jaws, it must be remembered that these organs are so much modified that in some insects the terms seem hardly applicable. Thus, a reference to the illustration of the head of that insect which is found too commonly in our metropolis will show that the four jaws, though springing from separate roots, are united to form a single style-like puncturing apparatus, and this is enclosed in the lower lip, which is a tube through which juices are sucked.

The head is so consolidated that it would at first sight suggest the idea that it consists of but one ring, corresponding with one annulus of a worm, and some have thought that this was really the case. There are, at least, three segments in the head of an insect, and the appendages which correspond to these may be easily enough seen in such a form as the familiar cockroach.

The first pair of appendages work from side to side and over the simple-toothed *mandibles;* on these follow the first pair of *maxillæ*, which consist of a number of separate pieces. The next, or second pair of *maxillæ*, have their basal parts fixed in the middle line to form the labrum, or lower lip, of most entomological writers.

The thorax, although it forms a more or less globular or cubical box, which lodges the muscles which ply the legs and wings, plainly consists of three rings or segments. This is apparent, not only on account of the number of appendages, but also, on examination, the plates of which it is composed show the lines of junction by sutures on the outside; while on the inside the edges of these are doubled in so as to form ridges, to which the muscles are attached. To the first segment, or *pro*thorax, are attached a pair of legs. They spring from below, and are extended outwards. The second segment, or *meso*thorax, has a pair of legs below, and generally a pair of wings, springing from the back. The hind segment, or *meta*thorax, has the same limbs as the preceding one. The legs are all jointed, the joints being of beautiful structure. The limb starts from a movable plate wedged in between the fixed plates of the body; this is called the coxa. Then comes a small joint which assists in allowing the limb to be rotated, and is called the trochanter. Beyond this is the femur, and to its end is attached, by a joint which only permits of an up-and-down movement, the usually long serrated or spined tibia. A string of five beaded joints forms the foot, the last of which is furnished with two curved hooks to lay hold on the minute roughnesses in the surface over which the insect crawls. Besides the claws, there are often two or three cushions of stiff hairs, which, aided by a sticky secretion, are very good sustainers of the light and strong creatures when they walk on the ceiling of a room. This description applies to the limb when most developed, as there is a vast variety in the composition of the limbs of insects. The legs are used not only for walking, but also for cleaning the body, the antennæ, and the wings. They are sometimes furnished with curious brushes and combs for effecting this purpose. The use which the working bee makes of its hind legs—namely, to store lumps of wax upon them, and so to carry a supply of this substance to its hive—will also occur to all bee-keepers.

GERMAN.—XL.

[*Continued from p.* 188.]

THE ADVERBS (*continued*).

(4) ADVERBS FORMED FROM VERBS.

ADVERBS are formed from verbs by suffixing to the radical part the termination -lich. All adverbs so formed, however, are equally employed as adjectives, thus:—

Glaublich (from glaub+en, to believe), credibly.
Sterblich (from ſterb+en, to die), mortally.
Kläglich (from klag+en, to lament), lamentably.
Merklich (from merk + en, to note, perceive), perceptibly.

(5) ADVERBS FORMED BY COMPOSITION.

Besides the classes given above, a numerous list of adverbs in German is produced by the union of various parts of speech. Thus, the word Weiſe (*mode, manner*), combined with nouns, forms a class of adverbs employed chiefly in specifying things individually or separately; thus, ſchrittweiſe, step by step; theilweiſe, part by part; tropfenweiſe, drop by drop. Weiſe is also added to adjectives; as, diebiſcherweiſe, thievishly; glücklicherweiſe, fortunately.

Sometimes an adverb and a preposition are united; examples of which may be found under the head of adverbs formed from pronouns.

Sometimes adverbs are formed by the union or the repetition of prepositions; as, durchaus, throughout, thoroughly; durch und durch, through and through.

Sometimes a noun and a pronoun joined together serve as an adverb; as, meinerſeits, on my side; dieſſeits, on this side; allerdings, by all means.

Sometimes one adverb is formed from another by the addition of a suffix; as, genugſam, sufficiently; sometimes by the union of another adverb; as, nimmermehr, nevermore.

Sometimes the several words composing a phrase are, by being brought into union, made to perform the office of an adverb; thus, fürwahr (for für wahr), verily; ſonſt (for the obsolete ſo ne iſt, *if it is not*), otherwise, else.

COMPARISON OF ADVERBS.

Many adverbs, chiefly, however, those expressive of manner, are susceptible of the degrees of comparison. The forms for these are the same in adverbs as in adjectives.

It must be observed, however, that when a *comparison*, strictly speaking, is intended, the form of the superlative produced by prefixing am should always be employed; as, er ſchreibt am ſchönſten, he writes the most beautifully (*of all*).

If, on the other hand, we purpose, not to compare individuals one with another, but merely to denote extreme excellence or eminence, there are three ways in which it may properly be done:—*First*, by using the simple or absolute form of the superlative; as, er grüßt freundlichſt, he greets or salutes in a manner *very* friendly, *very* cordially. *Secondly*, by employing aufs (auf+das) with the accusative, or zum (zu+dem) with the dative, of the superlative; as, aufs freundlichſte, in a manner very friendly; zum ſchönſten, in a manner very beautiful. *Lastly*, by adding to the simple form of the superlative the termination -ens; as, beſtens, the best or in the best manner; höchſtens, at the highest or at the most.

THE PREPOSITION.

The prepositions in German—that is, the words employed merely to denote the *relations* of things—are commonly classified according to the cases with which they are construed. Some of them are construed with the genitive only; some with the dative only; some with the accusative only; and some either with the dative or accusative, according to circumstances.

In every language the use of prepositions is difficult to master. Even in English, where there are no cases to cause confusion, the prepositions are constantly misapplied. The cases in German render the subject doubly hard, and you must study this section with care.

They may also, on a different principle, be divided into two general classes: the *primitive* and the *derivative*. The primitive prepositions always govern either the dative or the accusative; the derivative prepositions are found, for the most part, with the genitive only.

TABLE OF THE PREPOSITIONS.

(1) PREPOSITIONS CONSTRUED WITH THE GENITIVE.

Anſtatt, or ſtatt.
Außerhalb.
Diesſeit, or diesſeits.
Halb, halben, or halber.
Innerhalb.
Jenſeit, or jenſeits.
Kraft.
Längs.
Laut.
Oberhalb.
Trotz.
Um-willen.
Unfern.
Ungeachtet.
Unterhalb.
Unweit.
Vermittelſt, or mittelſt.
Vermöge.
Währent.
Wegen.
Zufolge.

(2) PREPOSITIONS CONSTRUED WITH THE DATIVE.

Aus.
Außer.
Bei.
Binnen.
Entgegen.
Gegenüber.
Gemäß.
Mit.
Nach.
Nächſt.
Nebſt.
Ob.
Sammt.
Seit.
Von.
Zu.
Zuwider.

(3) PREPOSITIONS CONSTRUED WITH THE ACCUSATIVE.

Durch.
Für.
Gegen, or gen.
Ohne.
Sonder.
Um.
Wider.

(4) PREPOSITIONS CONSTRUED WITH THE DATIVE OR ACCUSATIVE.

An.
Auf.
Hinter.
In.
Neben.
Über.
Unter.
Vor.
Zwiſchen.

(1) PREPOSITIONS CONSTRUED WITH THE GENITIVE.

We now give again the prepositions governing the several cases respectively, with their proper definitions; subjoining also some few observations on such of them as seem to require further explanation. And, first, we mention those construed with the genitive.

Anſtatt, or ſtatt, instead.
Außerhalb, without, outside.
Diesſeit, or diesſeits, on this side.
Halben, or halber, on account of.
Innerhalb, within, inside.
Jenſeit, or jenſeits, on that side, beyond.
Kraft, by virtue of.
Längs (also gov. dat.), along.
Laut, according to.
Oberhalb, above.
Trotz (also gov. dat.), in spite of
Um—willen, for the sake of.
Ungeachtet, notwithstanding.
Unterhalb, below, on the lower side.
Unfern, near, not far from.
Unweit, near, not far from.
Vermittelſt, or mittelſt, by means of.
Vermöge, by dint of.
Während, during.
Wegen, on account of.
Zufolge (also gov. dat.), in consequence of

OBSERVATIONS.

Anſtatt is compounded of an (*in*) and Statt (*place*), and these components may sometimes be separated; thus, an des Bruders ſtatt, *in* the brother's *stead*. In this case, the part Statt takes its proper character, which is that of a noun.

Halben, like wegen and um—willen, expresses *motive*. Strictly speaking, however, halben seems to point to a motive that is *direct*, *immediate*, and *special*; wegen indicates an object less *definite* and more *distant*; while um—willen looks to the *will*, *wish*, or *welfare* of that which is expressed by the genitive. These distinctions, however, are not always regarded, even by writers of reputation.

Halben or halber is always placed *after* the noun which it governs; thus, des Geldes halben, for the sake of money; Vergnügens halber, for the sake of pleasure. Halben is often united with the genitive of personal pronouns, in which case the final letter (r) is omitted, and its place supplied by t: thus, meinethalben (instead of meinerhalben), for my sake; deinethalben, for thy sake; ſeinethalben, for his sake, etc. So, too, it occurs in the compounds deßhalb, on account of that; weßhalb, on account of which; wherein, as in außerhalb, innerhalb, oberhalb, unterhalb, the form halben is shortened into halb In the last four halb has the sense of *part* or *side*; as, außerhalb, out*side*, etc

Wegen may either come *before* or *after* its noun; as, wegen der großen Gefahr, on account of the great danger; ſeiner Geſundheit wegen, on account of his health.

Um—willen is always separated by the genitive which it governs; thus, um Gottes willen, for God's sake.

Ungeachtet may either *pre*cede or *suc*ceed its noun; as, ungeachtet aller Hinderniſſe, notwithstanding all hindrances; ſeines Fleißes ungeachtet, notwithstanding his industry.

Vermöge, *by dint* or *means of*, indicates physical ability; as, vermöge des Fleißes, by means of industry. It thus differs from kraft, which points rather to the exercise of moral power; as, kraft meines Amtes, by virtue of my office.

Zufolge, when it comes *after* the word which it governs, takes the latter in the *dative*; as, dem Befehle zufolge, in consequence of (or pursuant *to*) the order.

Längs and trotz may also govern the dative.

(2) PREPOSITIONS CONSTRUED WITH THE DATIVE.

Aus, out, out of.
Außer, without, outside of.
Bei, by, near, with.
Binnen, within.
Entgegen, towards, opposite to.
Gegenüber, over against.
Gemäß, conformably with.
Mit, with.
Nach, after, to, according to.
Nächſt, next, next to.
Nebſt, together with.
Ob, over, at.
Sammt, together with.
Seit, since.
Von, from, of.
Zu, to, at.
Zuwider, against, contrary.

OBSERVATIONS.

Aus indicates the *place*, the *source*, or the *material* whence anything is produced; as, aus dem Hauſe, out of the house; aus Liebe, out of love; aus Nichts hat Gott die Welt gemacht, out of nothing has God made the world.

Außer differs from aus, in that it denotes *situation* rather than *transition*; thus, aus dem Hauſe marks *motion* from or out of the house, while außer dem Hauſe signifies position in respect to the house, that is, outside of the house, abroad; hence comes also the signification *besides*, *exclusive of*; as, Niemand außer mir war zugegen, no one besides, or except me, was present.

Bei shows the relation of *proximity* or *identity* in respect to persons, places, times, etc.; as, er wohnt bei ſeinem Bruder, he resides *with* his brother; bei dem Hauſe, *by* or *near* the house; bei der Schöpfung, *at* the creation; bei meiner Ankunft, *at* or *upon* my arrival; bei dem Plato, *in* Plato, that is, in the works of Plato. Bei is also used in making oath or protest; as, bei Gott; bei meiner Ehre, *by* God; *by* or *upon* my honour: a use easily derived from the primary signification of the word. It should be added that the German bei (unlike the English *by*) is not properly employed to denote the cause, means, or instrument of an action; this is done by the words durch, von, or mit · ich fahre mit der Eiſenbahn.

Binnen is used in denoting a limitation of *time*; as, binnen acht Tagen, within eight days.

Entgegen always comes *after* its noun, and denotes the relation of parties moving *towards* one another so as to meet: hence it gets the signification *opposite to*, *over against*; thus, der Knabe läuft ſeinem Vater entgegen, the boy runs *towards*, that is, *to meet* his father; dem Winde entgegen, *against* the wind.

Gegenüber marks an opposite *position* of things, and, like entgegen, comes *after* its noun: as, dem Hauſe gegenüber, *opposite to*, or *fronting* the house.

Mit signifies sometimes the relation of *union*; sometimes that of *instrumentality*; as, er arbeitet mit ſeinem Vater, he works with his father; mit einem Meſſer ſchneiden, to cut *with* a knife; sometimes, also, it indicates the *manner* of an action; as, mit Gewalt, mit Liſt.

Nach, in all its uses, has its nearest equivalent in the English word *after*; as, zehn Minuten nach vier, ten minutes *after* four; nach engliſcher Mode, *after* the English fashion; der Naſe nach, *after* (that is, *following* after) your nose; dem Strome nach, *after* (that is, *in the direction of*) the stream; der Beſchreibung nach, *after* (that is, *according to*) the description; wir gehen nach der Stadt, we are going *after* (that is, *in the direction of*, *towards*, or *to*) the city; das Schiff iſt nach Amerika beſtimmt, the ship is bound *after* (that is, *for*) America, etc.

When direction towards a *person*, instead of a place, is indicated, zu is employed; as, ich werde zu meinem Vater gehen, I shall go to my father. Sometimes nach is used in connection with zu; as, er lief nach der Stadt zu, he ran (literally, *after to*) *towards* the city. When it denotes direction *with*, as in the phrase dem Strome nach, following or going *with* the stream, it is put *after* the noun which it governs: so, also, when it has the kindred sense, *according to;* as, meiner Meinung nach, according to my opinion. If, however, in the latter case, a genitive depends on the noun under the government of the preposition, nach *precedes;* as, nach der Beſchreibung Schiller's, according to Schiller's description.

Nebſt and ſammt have the same *general* signification, *together with;* but, strictly speaking, differ in this, that ſammt not only indicates *conjoint*, but also *simultaneous* action; thus, Aaron ſammt ſeinen Söhnen ſollen ihre Hände auf ſein Haupt legen, Aaron together with (i.e., *simultaneously with*) his sons shall lay their hands upon his head.

Ob is seldom used except in poetry.

Von marks the *source or origin* of a thing, and has the same latitude of signification as its English equivalent *from;* thus, der Wind wehet von Oſten, the wind blows from the east; das Gedicht iſt von ihm, that poem is from (*by*) him. With an or auf following, it indicates the extent of a period of time: von der erſten Kindheit an, from earliest childhood on; von ſeiner Jugend auf, from his youth up.

Zu primarily is a mere sign of *transition*, but is made to denote a variety of cognate relations, from a state of motion to a state of rest. Examples best illustrate its use; thus, ich will zu meinem Vater gehen, I will go to my father; wir reiſen zu Waſſer und zu Lande, we travel by water and by land; zu Pferde, on horseback; zu Fuße, on foot; zu Hauſe, at home; zu jener Zeit, at that time; er hat mich zum (for zu dem) Narren gemacht, he has made me (*to become*) a fool; er thut es mir zu Liebe, he does it to (*show*) love for me. It is sometimes used as an adverb; as, geh zu, go on; zu viel, too much; mache die Thür zu, shut the door to.

Zuwider, *against*, *contrary to*, comes *after* the word which it governs.

(3) PREPOSITIONS CONSTRUED WITH THE ACCUSATIVE.

Durch, through.
Für, for.
Gegen or gen, towards.
Ohne, without.
Sonder, without.
Um, about, around.
Wider, against.

OBSERVATIONS.

Durch has its exact equivalent in the English word *through;* as, durch die Stadt gehen, to go through the city; durch Ihren Beiſtand, through your aid; das ganze Jahr durch (where, as often in English, the preposition comes *after* the noun), *the whole year through.*

Gegen (contracted, gen) indicates motion *towards;* and hence has the signification *opposite to;* but whether it marks direction towards in a manner friendly or otherwise must be determined by the context. In this respect it differs from wider, *against*, which denotes an opposition, doing or designing evil.

Ohne and ſonder are of the same import; but the latter is seldom used, and then only when the substantive has no article before it.

Um, like the English word *about*, indicates the going or being of one thing around another; and hence denotes also nearness, change of position, succession, etc.; thus, um den Tiſch ſitzen, to sit round the table; wirf deinen Mantel um dich, throw thy cloak about thee; um zwei Uhr, about (literally, *close about*, i.e., *exactly*) two o'clock; einen Tag um den andern, one day *about* another, that is, every other day; es iſt um ihn geſchehen, it is done *about* him, that is, it is over with him; um Geld ſpielen, to play about (*for*) money; um zehn Jahre jünger, younger about (*by*) ten years, etc. Before an infinitive preceded by zu (that is, before the *supine*, as it is sometimes called), um denotes purpose; as, um Ihnen zu zeigen, *in order* to show you; um zu ſchreiben, *in order* to write, or for the *purpose* of writing.

(4) PREPOSITIONS CONSTRUED WITH THE DATIVE OR ACCUSATIVE.

An, on, at, near.
Auf, on, upon.
Hinter, behind.
In, in, or into.
Neben, beside.
Über, over, above.
Unter under, among.
Vor, before.
Zwiſchen, betwixt, between.

OBSERVATIONS.

These prepositions govern either the accusative or the dative, but not without a difference of signification; for when motion *towards*, that is, motion from one point to another, is indicated, the accusative is required; when, however, motion or rest *in* any given place or condition is signified, the dative is used; thus, der Knabe läuft in den Garten, the boy runs *into* (motion *towards*) the garden; der Knabe läuft in dem Garten, the boy runs *in* (motion *within*) the garden. This is the *general* principle, which will be found, with more or less distinctness, everywhere to prevail in the use of the prepositions of this class. We subjoin a list of examples:—

Dat. An einem Orte wohnen, to dwell in or at a place.
Acc. An einen Freund ſchreiben, to write to a friend.
Dat. Schwach am Verſtande, weak in understanding.
Acc. Bis an den Abend, even to or until evening.
Dat. Am Morgen und am Abend, in the morning and in the evening.
Dat. Auf dem Lande wohnen, to live in the country.

Acc. Auf das Land reiſen, to travel into the country.
Acc. So viel auf den Mann, so much for a, or per man.
Acc. Auf deutſche Art, in (i.e., *following after*) the German way.
Dat. Er ſteht hinter mir, he stands behind me.
Acc. Er trat hinter mich, he stepped behind me.
Dat. Ich wohne in der Stadt, I live in the city.
Acc. Ich gehe in die Stadt, I am going into the city.
Dat. Er ſtand neben mir, he stood near to me.
Acc. Er ſtellte ſich neben mich, he placed himself near me.
Dat. Über der Arbeit, over (i.e., *while at*) the work.
Acc. Über meine Kräfte, beyond my strength.
Dat. Ich ſtand unter einem Baume, I stood under a tree.
Acc. Der Hund kriecht unter den Tiſch, the dog creeps under the table.
Dat. So will ich mich nicht vor dir verbergen, then will I not hide myself from thee.
Acc. Ich gehe vor die Thür, I go before the door.
Dat. Ich ſaß zwiſchen zwei Freunden, I sat between two friends.
Acc. Ich ſtellte mich zwiſchen beide, I placed myself between the two.

EXAMPLES ILLUSTRATING THE VARIOUS USES OF THE PREPOSITIONS.

The following examples, drawn, many of them, from the works of well-known German authors, will illustrate clearly the uses of the prepositions, and will prove at the same time an excellent reading lesson.

An.

Im Innern Deutſchlands geſchah', was von jeher geſchah', wenn es dem Throne an einem Kaiſer, oder dem Kaiſer an einem Kai'ſerſinne fehlte. (Schiller.)	In the interior of Germany events took place which have ever occurred before, when the throne was without an Emperor, or the Emperor without an imperial mind.
Wir ſtehen weit von einan'der ab an Jahren, an geprüf'tem Werth. (Göthe)	We stand far from each other in years, in recognised worth.
Er iſt an der Aus'zehrung geſtor'ben.	He (has) died of consumption.
Muß ich auch an deiner Liebe zweifeln? (Schiller.)	Must I likewise doubt of thy love?
Die Freunde werden irr' an dir! (Schiller.)	Thy friends are becoming perplexed about thee.
An die Angſt der Mutter denkſt du nicht.	Of the anxiety of the mother thou dost not think.
Er ſchrieb einen Brief an mich.	He wrote a letter to me.
(Er ſchrieb mir einen Brief.)	(He wrote me a letter.)
Man kennt den Vogel an den Federn.	One knows the bird by its feathers.
Die Nach'kommenſchaft des ſo gefürch'teten Karl V. ſchwebte in Gefahr', einen Theil ihrer Beſitz'ungen an die Türken, den andern an die Proteſtan'ten zu verlie'ren. (Schiller.)	The descendants of the formidable Charles V. were in danger of losing one part of their territories to the Turks, and the other to the Protestants.
Halte unverbrüch'lich feſt an dem Glauben an Gott, den Vater unſer Aller.	Hold inviolably fast to thy faith in God, the Father of us all.

Auf.

Wir waren auf einen Au'genblick auf die Straße gegangen, um uns den Zug an'zuſehen.	We had gone for a moment into the street, in order to look at the procession.
Der Bür'germeiſter iſt auf dem Rath'hauſe, und ſein Sohn iſt auf der Univerſität'.	The burgomaster is at the council-house, and his son is at the university.
Wir waren geſtern auf der Jagd, und gehen heute auf eine Hochzeit.	We were yesterday at the chase, and are going to-day to a wedding.
Sind Sie böſe auf mich?	Are you angry with me?
Auf Son'nenſchein folgt Regen.	Rain follows (upon) sunshine.

Bei.

Es ſteht bei mir, es zu thun, oder zu laſſen.	It depends upon me to do it or to leave it undone.
Bei jedem Abſchied zittert mir das Herz. (Schiller.)	At every farewell (departure) my heart trembles.
Bei aller ſeiner Klugheit läßt er ſich zu Thor'heiten verlei'ten.	With all his prudence he suffers himself to be beguiled into foolish actions.
Solch ein Geiſt, bei ſolch einem verdor'benen Charak'ter!	Such a mind, with such a depraved character!
Guſtav Adolph gewann' mit ſeinem Leben die Schlacht bei Lützen.	Gustavus Adolphus won with his life the battle at Lützen.
Das iſt nicht Sitte bei uns.	That is not the fashion with us.
Er nannte mich bei meinem Vor'namen (or Taufnamen).	He called me by my Christian name.
Ich leſe nicht gern bei einer Lampe.	I do not like to read by a lamp.
Er ſcheint nicht recht bei Sinnen zu ſein.	He seems not to be right in mind (in his right mind).
Er verbot' es bei Le'bensſtrafe.	He prohibited it on pain of death.

Bis.

Bis dieſen Au'genblick.	Till this moment.
Wir bleiben bis Abend.	We remain till evening
Bis dieſe Stunde weiß ich nicht, wie es ihm möglich gewe'ſen iſt, ſo zu leben, wie er lebte.	To this hour I do not know how it was possible for him to live as he did (live)
Er geht bis nach* Wien	He goes as far as (to) Vienna
Das Waſſer reichte ihm bis an den Hals	The water reached up to his neck
Bis auf Einen Punkt ſind ſie einig	One point excepted, they are agreed
Er geht nicht eher, als bis er ſeine Geſchäf'te been'digt hat	He does not go before he has finished his business

Shakespeare's House, Stratford on Avon

ENGLISH LITERATURE—X

[*Continued from p* 197]

THE ELIZABETHAN PERIOD—SHAKESPEARE

We have given a brief account of the earlier Elizabethan dramatists, and have seen that some of them at least were men of rare genius, and produced works of great power and beauty. But their fame was soon eclipsed, even in their own days, as it has been almost completely in later times, by the splendour of their great contemporary, the greatest by far, not only amongst the Elizabethan dramatists, but in the whole catalogue of England's literary worthies.

There is hardly any great writer, save Homer, of whose actual history less is known than of Shakespeare's He was born in April, 1564, at Stratford-upon-Avon, in Warwickshire, being the son of John Shakespeare and his wife, Mary Arden or Arderne John Shakespeare, the poet's father, was an alderman of the town of Stratford-upon-Avon, and carried on the trade of a wool-dealer and skinner, and probably that of a glover At one time he appears to have been a very prosperous man, and his wife, the poet's mother, was of an ancient and aristocratic Warwickshire family But in his later years, and at the period when his son was growing into manhood, his fortunes had declined, and he became involved in poverty and debt. Of the earlier youth and education of William Shakespeare we know absolutely nothing with certainty We have no record of where he was at school or what his employment was after he left it In November, 1582, at the age of eighteen, he was married to Anne

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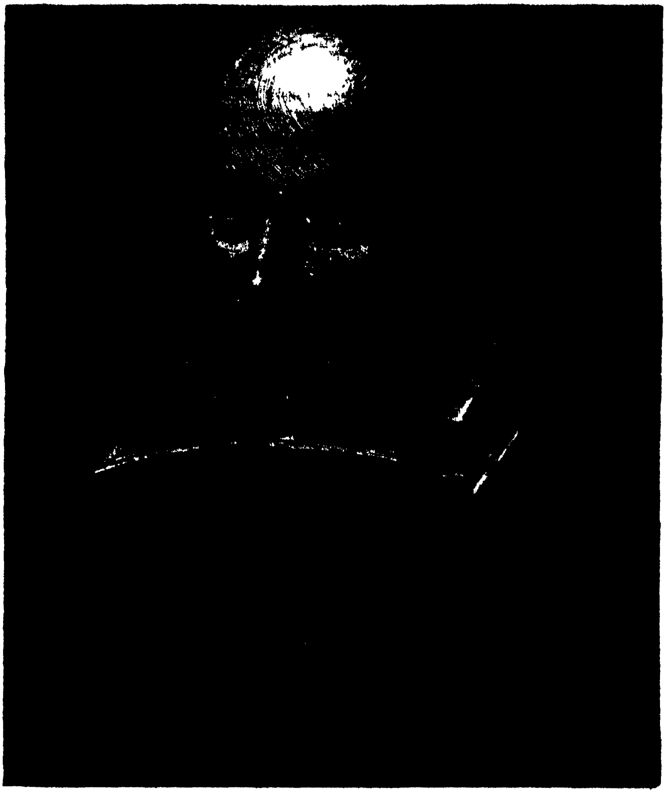
* Bis is often placed before the prepositions auf etc , as, bis auf, bis nach, bis zu &c. The pupil will observe that some of the prepositions are employed in this section as adverbs.

Hathaway, the daughter of a small farmer living at Shottery, not far from Stratford. His wife was several years older than himself; and the fact that their first child was born but a few months after marrying seems to show that the circumstances of the marriage were not much to the credit of the parties, and to confirm the traditions of Shakespeare's early wildness. A very short time afterwards, about 1587, there is no doubt that he left his native town and settled in London, and became a member of a theatrical company. From the little that we know of Shakespeare's position and circumstances at Stratford, and what we know of the powers he in fact possessed, and of which he must probably even then have been in some degree conscious, this change from Stratford to London seems to require little explanation; but tradition has been busy finding occasions for it. The best-known story upon this subject is that Shakespeare, with some of his wild companions, was guilty of the common, and in those days not very heinous offence, of deer-stealing in the park of Sir Thomas Lucy at Charlcote. For this offence he was treated by Sir Thomas with a severity which he resented; and he showed his resentment by writing a set of doggrel verses in ridicule of his enemy, and fixing a copy on his gate: an offence which roused the anger of the local magnate to such an extent that Stratford was no longer a safe abode for Shakespeare, and hence his migration to London. This story rests upon no sufficient evidence. But it has in itself no improbability, and the tradition has more consistency than most of the same class. Within a short time after Shakespeare's death old people in the neighbourhood professed to give fragments of the very ballad which did the mischief. And, whatever the cause may have been, there can be no doubt that later in life Shakespeare bore some grudge against the Lucy family, and intended to ridicule them in the person of Justice Shallow, in the *Merry Wives of Windsor*, who bore as arms "a dozen white luces" in "his old coat" (luces—that is, pike fish—being in fact borne by the Lucys), or as Sir Hugh the Welshman expressed it, "a dozen white louses," which "become an old coat well." Shallow's complaint against Falstaff, "You have beaten my men, killed my deer, and broke open my lodge," has been thought by some to refer to and confirm the story of the deer-stealing. On the other hand, however, this passage may possibly explain the origin of the story.

Whatever the cause of Shakespeare's move to London may have been, we find him very soon afterwards a member of the Globe company of players. This was the most important of the theatrical companies which were at this time becoming so numerous in London, and it had two theatres under its control, the Globe in Southwark, for summer use, and the Blackfriars theatre for winter. Tradition has again been very busy over this period of Shakespeare's life, and the mode in which he gained admission to the company. But the stories of his having held horses at the theatre door, and other tales of the same class, are wholly unworthy of credit. The stage was not a profession very difficult of access; it was then, as it has often been since, the common refuge for "every one that was distressed, and every one that was in debt, and every one that was discontented"; and Shakespeare, in his distress, adopted it. Like most of the great dramatists of his day, he began his connection with the stage, not as an author, but as an actor. As such, there is no reason to suppose that Shakespeare showed any remarkable talents, or attained more than very moderate distinction; but the true bent of his genius soon made itself known. He began his career as a dramatic author, like many others, by improving and adapting to the purposes of the day old pieces forming part of the stock of the company; and from this inferior office he advanced to the nobler function of wholly original composition.

From the time of Shakespeare's joining the Globe company his career seems to have been one of unbroken success. The company itself prospered, and had the prudence or good fortune to steer clear of those collisions with the City authorities from which other companies suffered so much. And Shakespeare's own position among his partners steadily improved, till, at the accession of James I., in the renewed licence then granted to the company, his name stands second among the adventurers. He had never abandoned his connection with his native town of Stratford, but seems, during the whole period of his life in London, to have visited it frequently. And there he invested the proceeds of his share in the theatre. In 1597 he bought the estate of New Place, in Stratford, and built there the house which became famous in consequence. In 1602 he purchased further property in the same neighbourhood. In 1611 he sold most of his interest in the theatre, finally abandoned all connection with the stage, and retired to end his days at Stratford. His only son had died in boyhood some years before. Of his two daughters, one had been married for several years to a physician of some eminence, and she and her husband resided with him; the other remained unmarried until a short time before her father's death. Of Shakespeare's life at Stratford during the few years between his retirement from the theatre and his death we can learn nothing, except that rumour seems to indicate that he maintained to the last his intimacy with his old literary associates. He died on the 23rd of April, 1616, according to tradition on the anniversary of his birth, and was buried in the parish church of Stratford.

From what we have already related of the history of Shakespeare's life, it will be apparent that, whatever in his youth he may have been, in his mature years he was a prudent and careful man in the management of his worldly concerns; and the kindliness and amiability of his disposition secured for him in a peculiar degree the esteem and affection of his brother actors and the most eminent of his literary contemporaries, as well as the warm friendship of the chief patrons of literature in his day. He did not absolutely escape the hostility of rival dramatists and angry pamphleteers; and the habit indulged by Shakespeare in the early part, at least, of his career, as well as by other dramatists, of adapting the works of earlier writers, laid him open to the charge of stealing the fruit of other men's labours. But, on the whole, the respect and popularity which he enjoyed secured for him an unusual immunity from controversy or attack.



SHAKESPEARE. *(The Portrait in the First Folio.)*

Few subjects have given rise to more discussion than the question of the extent of Shakespeare's learning; and, the known facts being scanty, upon few subjects have more extravagant conjectures been indulged in. As to where or in what way he received any systematic education, nothing, as we have pointed out, is recorded. Ben Jonson, in the laudatory verses which he wrote upon him, says that he had "small Latin and less Greek." In his plays the subjects of which are derived from classical sources, it is beyond doubt that he worked from translations, not from the original; and several contemporary allusions make it clear that, as compared with his brother dramatists of the day, he was regarded as an unlearned man. But it must be remembered that at that time the stage was adorned by the profound learning of Ben Jonson himself; that some of the other dramatists, though no rivals of Jonson, were learned men; and that most of them had at least such culture as a university education secured. The matter being thus, to a certain extent, left at large, one class of critics have represented Shakespeare as an absolutely illiterate man, while others, with less excuse, have sought to endow him with a knowledge of all the European languages, ancient and modern, and indeed, of almost all branches of learning. The truth plainly lies somewhere between these two extremes. We cannot reject the testimony of his contemporaries that he was a man of but scanty learning, and especially that he was a poor linguist.

But, on the other hand, the great uses of learning to a poet are to remove local and national prejudices, and narrowness and distortion of taste and judgment, and to supply materials for the mind and imagination to work upon; and, judged by these tests, it cannot be denied that Shakespeare had acquired such a degree of learning as was needed for the development of his poetical powers.

If the details of Shakespeare's personal history are obscure, the history of his works is almost more so. Successive generations of critics and antiquaries have laboured with a zeal almost fanatical in bringing to light every fragment of evidence, internal or external, bearing upon the history of Shakespeare's plays, with extremely meagre results.

It will be convenient to mention, in the first place, Shakespeare's poems, before going on to notice his plays—the more so as he appeared as a poet before he did as a dramatist. "The first heire of my invention," to use his own words, was the poem of "Venus and Adonis." This poem was published in 1593, but was probably written a good deal earlier. It is a narrative poem on the well-known story which its name indicates. The subject is not a very attractive one to the modern reader, but it shows in a high degree the fertility of imagination, judgment, good taste, and sense of harmony which are among the peculiar characteristics of Shakespeare. This was followed in the next year by the "Rape of Lucrece," a poem somewhat similar in character. Both these works, especially the former, attained a great and immediate popularity. The "Passionate Pilgrim," published in 1599, was a collection of poems published in Shakespeare's name, though almost certainly without his consent; many of the pieces in it are undoubtedly by other authors, but some are certainly his. His "Sonnets" were not published till 1609, but it is probable that they were written at intervals extending over many years preceding that date. The "Sonnets" have given rise to one of the most curious and one of the most fruitless controversies in the whole history of literature. As published, they were dedicated to "Mr. W. H.," and speculation has been busy as to who the W. H. could be to whom these tender and beautiful outpourings of love and reproach were addressed. But no clue to the identity of W. H. on which the slightest reliance can be placed has been discovered; and there is no sufficient ground for assuming that the "Sonnets" were really addressed to the same person to whom, when collected, they were dedicated, or even to any one person at all.

The order of Shakespeare's plays, and the dates at which they were written, it is for the most part quite impossible to determine with any real certainty. But as the attempt has been very often made, and by very eminent critics, and as anything that can be learned upon this subject is important and instructive, we shall briefly indicate what materials there really are for ascertaining to any extent the history of the plays.

The external evidence is of the following kinds: A certain number of the plays were published singly during Shakespeare's life. And of course the date of publication gives us the latest date at which each play can have been composed. But it gives us no more. We know that many of Shakespeare's plays had been acted for years before they were printed, a large number never having been published till some years after his death. The plays thus printed during Shakespeare's life were—*Richard II.*, *Richard III.*, and *Romeo and Juliet*, in 1597; *Love's Labour's Lost*, and *Henry IV.*, *Part I.*, in 1598; *Henry IV.*, *Part II.*, *Henry V.*, *Merchant of Venice*, *Midsummer Night's Dream*, *Much Ado about Nothing*, and *Titus Andronicus*, in 1600; *Merry Wives of Windsor*, in 1602; *Hamlet*, in 1603; *King Lear*, in 1608; *Troilus and Cressida* and *Pericles*, in 1609. But in some instances the first quarto edition differs very materially from the play as we now have it; the quarto *Hamlet* especially is probably only a first sketch, afterwards worked up into the more complete play.

We learn some further information about Shakespeare's plays from a passage in the "Palladis Tamia" of Francis Meres, published in 1598. He says:—"As Plautus and Seneca are accounted the best for comedy and tragedy among the Latines, so Shakespeare among the English is the most excellent in both kinds for the stage: for Comedy witness his *Gentlemen of Verona*, his *Errors*, his *Love's labour's lost*, his *Love's labours' wonne* [that is, no doubt, *All's Well that Ends Well*], his *Midsummer's night dream*, and his *Merchant of Venice;* for Tragedy his *Richard the 2*, *Richard the 3*, *Henry the 4*, *King John*, *Titus Andronicus*, and his *Romeo and Juliet*." And from stray entries in contemporary diaries and other similar sources we learn that certain plays were in existence at an earlier period than they could otherwise have been shown to exist. In this way we know from the diary of a Middle Temple student named Manningham that *Twelfth Night*, though never published till after Shakespeare's death, was acted in the Middle Temple Hall as early as 1602.

The internal evidence as to the chronology of Shakespeare's plays is of two kinds. In the first place, many of the plays contain manifest allusions to contemporary events, allusions in some cases so pointed that they could only have been written when the events referred to were fresh in the public mind. But the value of these allusions as an index of date becomes comparatively small when we recollect that many, if not most, of the plays were acted long before they were printed; and many of them undoubtedly underwent much change from their original form before they reached the shape in which they have come down to us, and that such allusions as we have referred to may well have been inserted long after the plays were first written. The other branch of internal evidence upon the question is of greater value. It is derived from the character of the plays themselves. It is impossible for anyone to believe that the greatest efforts of Shakespeare's genius, such as *Macbeth*, *Othello*, and *King Lear*, are the work of a very young or inexperienced writer. And it is difficult to resist the conclusion, so forcibly urged by some critics, that plays in which we find one peculiar aspect of the problem of life, or one type of character strongly marked, belong to the same period of their author's life. Thus, there is great probability that such plays as *Hamlet*, *Othello*, *Lear*, and *Macbeth* were written within short intervals of one another. Again, peculiarities of outward structure—such, for instance, as the prevalence of rhymed couplets in one group of plays, and their absence in another, etc—are deserving of careful consideration. There is some reason for thinking that the prevalence of rhyme in any play is in general an indication of early date.

Such being, in short, the materials at our command, it is evident that any chronological arrangement can be no more than a vague approximation to the truth. We shall not, therefore, attempt such a classification; but shall rather, when speaking of the plays individually, point out to what period each may with most probability be referred.

The first collected edition of Shakespeare's plays was given to the world by Heminge and Condell, two of his brother actors of the Globe Company in 1623, seven years after the author's death. This edition was in folio, and is commonly known as the first folio. The second complete edition, also in folio, appeared in 1632, the third in 1664, and the fourth in 1685.

An authoritative chronological arrangement of the plays of Shakespeare being unattainable, various other modes of arrangement have been adopted by different editors and critics. Some, for instance, have classified them according to the sources whence the stories of the plays were originally derived, whether from history more or less authentic, or from mere fiction. But it can hardly be of much use to the student, or assist him much in his study of Shakespeare, to distribute the plays by reference to a circumstance which in Shakespeare's eyes was evidently of very little importance, and is of still less importance to us, and which throws absolutely no light upon the character of the plays themselves. A distribution which places *Hamlet* and *King Lear* in one class and *Othello* in another is not a very instructive one. By far the most convenient classification, we think, is the old-fashioned and customary one, which divides the plays into comedies, histories, and tragedies. This classification is historically correct, for the three kinds of plays with which it deals—though in Shakespeare's day the difference between them was not always very strongly marked—were much more distinct, as we have already seen, in their origin. *Gorboduc*, *Gammer Gurton's Needle*, and Bale's play of *King John*, belonged far more markedly to distinct classes of composition than *Othello*, the *Merchant of Venice*, and *Richard II*. This division, too, of the drama was one unquestionably quite familiar to Shakespeare himself, and was applied to his plays by his own contemporaries. Nor is there any strong objection to the division. Some of the comedies, no doubt, have a tragic element in them; comic scenes in the tragedies are general, indeed almost universal; and there are some few plays about which a doubt may arise to which class they shall most appropriately be assigned.

COMMERCIAL CORRESPONDENCE.—V.

[*Continued from p. 199.*]

FRENCH, GERMAN, AND ENGLISH.

26.—Letter from an Agent advising Receipt of an Account, and his Operations therewith.

Paris, December 2nd, 1891.

To the Directors of the Western Banking
Corporation (Limited), Manchester.

Gentlemen, I have herewith the pleasure to inform you that I have this day received from Mr. Bernard the sum of fr. 250,000, which, according to your instructions, I have handed over to Messrs. Moullyn Bros., requesting them to remit it to you in short bills on London at the most favourable rate of exchange, or, if it should be more convenient to them, to transfer the above amount to your credit with one of their London correspondents.

I am, Gentlemen,
Your obedient servant,
Frederic Tourville.

Paris, le 2 décembre, 1891.

À Messieurs les Directeurs de la Western Banking Corporation (Limited), à Manchester.

Messieurs,—J'ai l'avantage de vous informer par la présente que j'ai reçu aujourd'hui de M. Bernard la somme de fr. 250,000, que, conformément à vos instructions, j'ai versée chez Messieurs Moullyn Frères, en les priant de vous la remettre en papier court sur Londres au meilleur change possible, ou, s'il entrait mieux dans la convenance de ces derniers, de faire transférer ce montant à votre crédit chez un de leurs correspondants de Londres.

Recevez, Messieurs, l'assurance
de ma parfaite estime,
FRÉDÉRIC TOURVILLE.

Paris, 2 December, 1891.

An die Direction der Weſtern Banking Corporation (Lim.), Mancheſter.

Es gereicht mir zum Vergnügen Ihnen mitzutheilen, daß ich heute von Herrn Bernard die Summe von fs. 250,000 empfing, welche ich in Uebereinſtimmung mit Ihren Inſtructionen an Herren Gebrüder Moullyn aushändigte, mit dem Auftrage ſie Ihnen in kurzer Sicht auf London zum günſtigſten Curſe zu remittiren, oder, falls es ihnen beſſer conveniren ſollte, obige Summe zu Ihren Gunſten einem ihrer Londoner Geſchäftsfreunde zu überweiſen.

Hochachtungsvoll,
Frederic Tourville.

27.—LETTER REFUSING TO SUPPLY GOODS ON CREDIT.

London, January 17th, 1891.

Messrs. A. Perrin & Co., Paris.

In answer to your note, I beg to state that it is impossible for me to open any new accounts.

The price of the goods ordered is 570 francs.

If you will confirm the order, and, as is customary, accompany it by a bank-post bill on London, or a bill payable at sight on Paris, I will at once send the articles you desire to your agent.

Waiting your reply,
I have the honour to be,
Gentlemen,
Your obedient servant,
LEWIS PRATT.

Londres, le 17 janvier, 1891.

Messieurs A. Perrin & Cie, à Paris

En réponse à votre lettre, j'ai l'honneur de vous informer que je ne puis ouvrir de nouveaux comptes.

Le prix des articles que vous me demandez est de 570 francs.

Si vous voulez bien m'en confirmer la demande, et l'accompagner comme d'usage de son solde en un mandat sur la banque de Londres ou un bon à vue sur Paris, je remettrai aussitôt chez votre commissionnaire les articles que vous désirez.

En attendant vos ordres,
J'ai l'honneur d'être,
Messieurs,
Votre obéissant serviteur,
LEWIS PRATT.

London, 17 Januar, 1891.

Herren A. Perrin & Co., Paris.

In Beantwortung Ihrer Note erlaube ich mir zu bemerken, daß es mir nicht möglich iſt, neue Contis zu eröffnen.

Der Preis der beſtellten Waren iſt fs. 570.

Im Falle Sie die Order beſtätigen, und, wie üblich, eine Poſtanweiſung auf London, oder einen Sichtwechſel auf Paris beifügen, werde ich die von Ihnen gewünſchten Artikel ſofort an Ihren Agenten abſenden.

Ihrer Antwort entgegenſehend zeichne ich,
Hochachtungsvoll,
Lewis Pratt.

28.—LETTER ACKNOWLEDGING RECEIPT OF REMITTANCES.

London, January 23rd, 1891.

Messrs Daniel Bros., Liverpool.

Gentlemen,—Your favour of the 7th inst. came duly to hand covering your remittances for

£148	12	6	pro	18th February
225	6	0	„	25th „
420	0	0	„	5th March
£793	18	6	on London,	

which we place to your credit under usual reserve.

We remain, Gentlemen,
Yours respectfully,
A. BROWNLOW & CO.

Londres, le 23 janvier, 1891.

Messieurs Daniel Frères, à Liverpool,

Messieurs,—Votre honorée en date du 7 courant nous est bien parvenue couvrant vos remises de

£148	12	6	au	18 février
225	6	0	„	25 „
420	0	0	„	5 mars
£793	18	6	sur Londres,	

que nous passons à votre crédit sous les réserves d'usage.

Recevez, Messieurs,
nos salutations distinguées,
A. BROWNLOW & CIE.

London, 23 Januar, 1891.

Herren Gebrüder Daniel, Liverpool.

Ihr Werthes vom 7 curr. iſt zur Hand, mit Ihren Rimeſſen von:

£148 12 6 per 18 Februar
225 6 0 „ 25 „
420 0 0 „ 5 März

£793 18 6 auf London,
denen wir uns unter üblicher Reſerve in Ihr Haben bedienen.

Hochachtungsvoll,
A. Brownlow & Co.

29.—LETTER ACKNOWLEDGING RECEIPT OF MONEY FROM AGENT.

Manchester, December 12th, 1891.

Messrs. W. Carter & Co., Dublin.

Dear Sirs,—Without any of your favours to reply to, we herewith beg to inform you that we have to-day received from Messrs. Hawkes & Co., of your city, for your account, £4,200, which we place to your credit under to-morrow's date.

We are, dear Sirs,
Yours truly,
S. BARRETT & Co.

Manchester, le 12 décembre, 1891.

Messieurs W. Carter et Cie, à Dublin.

Chers Messieurs,—Sans aucune des vôtres à répondre, nous avons l'avantage de vous informer par la présente que nous avons reçu aujourd'hui de Messieurs Hawkes et Cie, de votre ville, pour votre compte, £4,200, que nous passons à votre crédit, valeur à demain.

Recevez, chers Messieurs,
Nos sinceres salutations,
S. BARRETT & Cie.

Mancheſter 12 December, 1891.

Herren W. Carter & Co, Dublin

Ohne Ihre werthen Nachrichten geblieben, theilen wir Ihnen hierdurch mit, daß wir heute von Herren Hawkes & Co dort, für Ihre werthe Rechnung £4,200 empfingen, welchen Betrag wir per Morgen Ihrem Conto gutſchreiben werden.

Hochachtungsvoll
S. Barrett & Co.

30.—LETTER ABOUT NON-ACCEPTED BILLS

Liverpool, September 28th, 1891.

Messrs. Costenoble, Lewis & Co, San Francisco.

Gentlemen,—In answer to your favour of June the 26th, I return you the enclosed Bill on Smith Bros. of

Dollars 1,950, with the protest for non-acceptance, for the costs of which you will please to credit me with

Dollars 3.—I am in a similar position as yourselves, having also a bill in hand on the same Smith Bros. of

Dollars 1,428, drawn by Jones & Co., of your town, payable the 20th October, which he has also refused to accept, and which I enclose, with the protest, requesting you to exact a sufficient security from the drawers, and to inform me of the result. Begging you beforehand to excuse the trouble I am occasioning,

I have the honour to be, Gentlemen,
Your obedient servant,
LEWIS MARTIN.

Liverpool, le 28 septembre, 1891.

MM. Costenoble, Lewis et Cie, à San Francisco.

Messieurs,—En réponse à votre lettre du 26 juin, je vous renvoie ci-inclus la lettre de change sur Smith Frères de

Doll. 1,950, avec son protêt, faute d'acceptation, dont il vous plaira de me créditer le coût de ———.

Doll. 3.—Je suis dans le même cas que vous-mêmes, ayant aussi une lettre de change sur ces MM. Smith Frères de

Doll. 1,428, tirée par Jones et Cie, de votre ville, payable le 20 octobre, dont il a aussi refusé l'acceptation, et que je vous envoie ci-incluse avec son protêt, en vous priant d'exiger une sûreté suffisante des tireurs et de m'informer du résultat. En vous demandant pardon d'avance de l'embarras que je vous cause,

J'ai l'honneur d'être, Messieurs,
Votre tout dévoué,
LEWIS MARTIN.

Liverpool, 28 September, 1891.

Herren Coſtenoble, Lewis & Co, San Francisco.

Antwortlich Ihres Geehrten vom 26 Juni ſende ich Ihnen einliegende Tratte zurück von

Dollars 1,950 auf Gebrüder Smith, und füge ferner den Proteſt für Nicht Acceptirung bei, mit der Bitte mich mit

Dollars 3 zu erkennen Ich befinde mich in einer ähnlichen Lage wie Sie, indem ich auch einen Wechſel auf die gleiche Firma in Händen habe, von

Dollars 1,428, von Jones & Co dort gezogen und zahlbar am 20 October, deſſen Acceptirung gleichfalls verweigert wurde. Ich erlaube mir Ihnen dieſen Wechſel, mit dem Proteſt, einzuſenden und bitte Sie, auf einer genugenden Sicherheit den Bezogenen gegenüber zu beſtehen und mich von dem Reſultat zu benachrichtigen. Indem ich Sie im Voraus für die verurſachte Mühe um Entſchuldigung bitte, zeichne ich,

Hochachtungsvoll,
Lewis Martin.

ARCHITECTURE.—VIII.

[*Continued from p.* 205.]

THE GOTHIC OR POINTED STYLE IN FRANCE.

IN our lesson on the Romanesque style we commenced with Italy and Germany, where its first great developments took place. So far, in fact, had these countries advanced in the evolution of a perfected round-arched style that they would seem to have preferred, in the latter country at all events, to adhere to the problems then being solved rather than to launch out into the new forms which the pointed arch in vaulted construction was leading to elsewhere.

France, on the other hand, being separated into a number of distinct provinces, each with an architectural phase of its own, and all more or less imperfectly developed, was ready to accept and to work out the solution of new problems. When, therefore, under the reigns of Louis le Gros and Louis le Jeune, the monarchy of France began to revive, and under the reign of Philip Augustus and St. Louis to consolidate itself, a most favourable occasion presented itself for the development of a national style The reflex of this consolidation was shown in the erection of the magnificent cathedrals of Chartres, Paris, Rheims, Amiens, Noyon, Laon, Beauvais, Bourges, and from thirty to forty other cathedrals of the first class, all of which belong to this century and a half of great prosperity and of gradually increasing power. It was in these buildings that in a comparatively short space of time the elements of a new style were evolved, in which the pointed arch, as introduced into vaulted and ribbed construction, formed the chief factor.

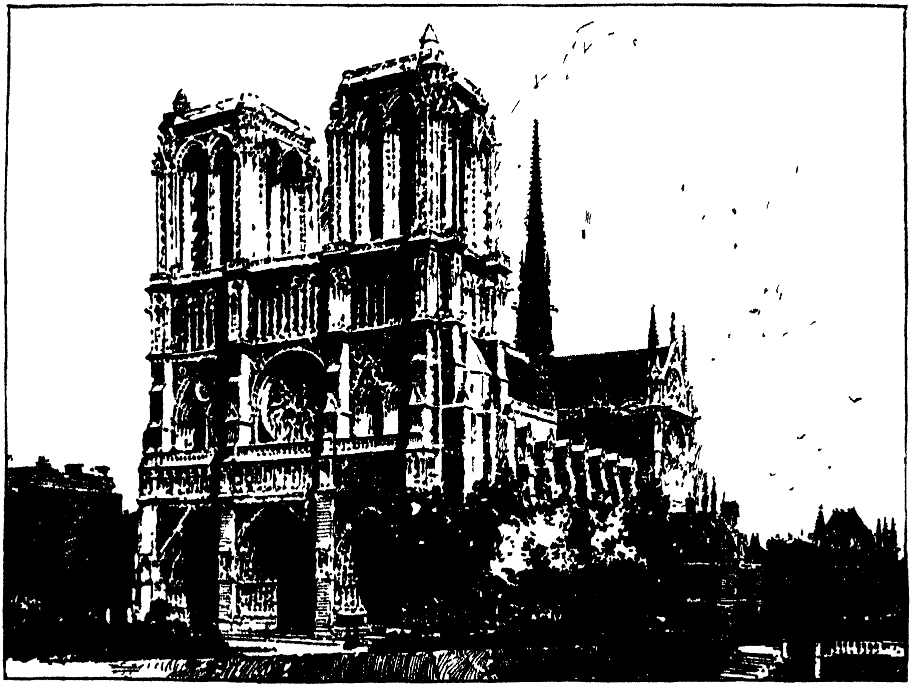


Fig. 28 —NOTRE DAME DE PARIS.

As we have already noted, the pointed arch had long been recognised as a stronger form of arch than the semi-circular: it had been used in the mosques of Egypt and Syria ; and even in France in St Front, at Perigueux, dating from the middle of the eleventh century, it had been employed to carry the pendentives of the domes At Carcassonne, also completed in the year 1100, the nave was covered with a pointed barrel vault. The constructional value of the pointed arch, therefore, was well known, but it was its adoption in intersecting vaults which led to the great change.

We have already pointed out in lesson VII. that in the vaults over the nave, owing to the fact that the latter was twice the width of the aisle, and the earlier vaultings were invariably over square bays, there were two vaulted aisle bays to one nave bay. The alternate piers, therefore, were unequally weighted : to obviate this, an intermediate rib was

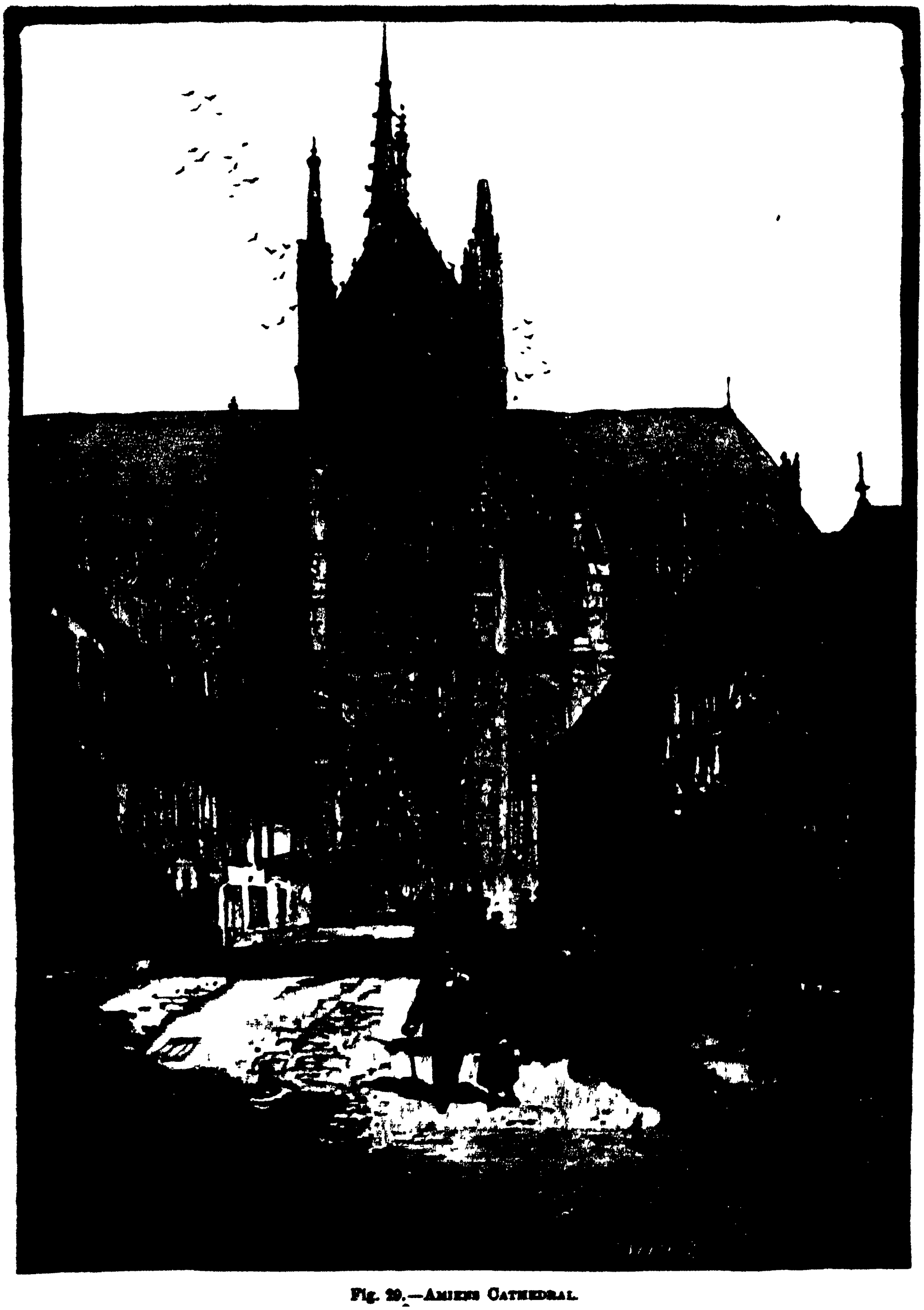


Fig. 29.—Amiens Cathedral.

thrown across the nave bay, dividing it into six compartments (known as sexpartite) of which we have examples in the Abbaye-aux-Hommes, Caen, and in the cathedrals of Paris, Laon, and others. The arched ribs across the nave, *b*, were then twice the width of the wall ribs, *c*, or those built into the nave wall; and to bring the summit of the arches to the same height, they had to be stilted. This led to grave difficulties in the vaulting, which were at once met by the introduction of the pointed arch. The diagonal rib was made circular, a slightly pointed arch, *b*, was employed for the transverse rib, and an acutely pointed arch, *c*, for the wall rib, and thus this apparently simple invention solved the great problem. The next change was to return to the quadripartite vault of oblong form, in which the square bay was divided into two oblong bays.

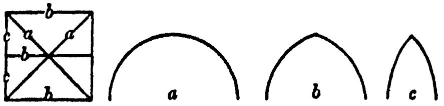


Fig. 30.

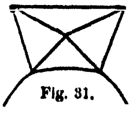


Fig. 31.

(The first introduction of the pointed arch actually took place at St. Denis in the aisles round the apse, where the vaulting presented a more difficult complication, and there the diagonal ribs are not in one vertical plane but rise each independently to the centre of the aisle.)

The adoption of the pointed arch for the ribs of the vault did not immediately lead to its universal use, and for a time, owing perhaps to the greater simplicity and beauty of its form, the circular arch was used to span openings of small dimension, the pointed arch being introduced for those of greater span or when requiring special strength. Beyond the constructional value, however, the pointed arch was found to possess certain proportional values which the circular arch even when stilted did not possess; and an arcade the width of opening in which might be half the height up to the springing, when spanned by an equilateral arch, for instance (the height of which is equal to its width), assumed a better proportion than when a circular arch was used, in which the height would only be half the width. The necessity for harmony also in the arches used probably led to a pointed arch being always used, though the proportions adopted might vary.

The introduction of the pointed arch in vaulting was only one of the important changes in construction which had been made since Roman times, so that it becomes necessary now to describe others which tended to the further development of the style. With an ordinary barrel vault, such as exists in the chapel of the Tower of London, for instance, the resistance to the vault is continuous, and requires very thick walls to meet it. By the employment of intersecting barrel vaults the Romans brought the weights of the vaults on to the end walls or on to piers. The resistance to the thrust, however, which, owing to its concentration, became more important to meet, was effected by carrying buttresses across the aisles. In the case of the basilica of Maxentius at Rome these form solid walls with only a small opening or door in the lower part. Such an arrangement in an ordinary church would interfere with the free circulation in the aisles, and although it was possible, as at Spires and at Worms, to employ piers of great massiveness which would be of sufficient power and weight, especially when supported by the aisle transverse ribs, they became altogether impossible when dealing with the columns or piers of an apse. The Gothic architects then discovered that the strength of a buttress depended, firstly, on its depth, that is to say, its horizontal distance from the springing of the vault, and secondly, on the weight of the farthest pier, and they accordingly invented what is known as the flying buttress, which consists of one or more arches thrown across the aisle, and above its roof, from the solid portion of the vault just above the springing to piers or buttresses outside the aisle wall; and if there were chapels outside the aisles, then carried by other flying buttresses to piers outside the chapel. When once the full resistance of the thrust was adequately met, they then found that the actual weight could be carried by columns or piers within the church of comparatively small dimension, and this gave increased space to the interior of the church. The weight which is carried by the pillars of the apses of some of the French cathedrals is enormous, showing the very high quality of the calculations made by French architects when working out the problems of thrust and counter-thrust.

It follows, therefore, from the description just given, that the weight of the vault, both of nave, choir, and apse, and of the aisles round, being carried on the piers, and the thrust of the same being transmitted to piers outside the aisles or chapels, the wall which remained had but little work to do beyond increasing by its own weight that which had to be carried on the piers, and acting as a tie between these piers to strengthen them. At first the openings of the windows were comparatively small, and consisted generally of twin lights with a small circular window above.

When, however, in the twelfth century in France painted glass came into use, the French architects availed themselves of all the width they could obtain between the main piers of the church, and by throwing arches across from pier to pier gradually evolved that beautiful feature known as the traceried window, subdividing the lower portion by a series of small piers called mullions, and filling the upper part with the arch by a continuation of these lines in various novel forms, constituting what is known as tracery. So important an element did this feature become in the development of the French Gothic style that it has been suggested by Fergusson it might claim to be called the Painted-glass style.

So far we have dwelt on the chief changes which had taken place in the disposition and arrangement of the Christian church, and on the causes which led to the development of the Gothic style as distinct from the Romanesque style: we may now pass on to a description of the principal cathedrals and churches.

The great architectural epoch of Central France commences with the building of the church of St. Denis under the Abbé Suger in 1144, in the reign of Louis le Gros. It culminates perhaps in the Sainte Chapelle at Paris, and it terminates, so far as simple purity of design is concerned, with the church of St. Ouen at Rouen in 1339. Within these two centuries were built at least fifty cathedrals of great size, not to mention numerous abbeys and churches which sometimes in size rival the cathedrals.

Of the cathedrals the most important are those of Chartres, Rheims, Paris, Amiens, Beauvais, Noyon, Laon, Soissons, Sens, Bourges, Le Mans, and Rouen. No one of them possesses all the highest qualities, as we found at Karnak in the Egyptian style, in the Parthenon in the Greek style, or in the church of St. Sophia in the Byzantine style. These qualities, however, are said to be found in four examples which are quoted as "the wonders of France," viz.: the tower and spire of Chartres, the porch of Rheims, the nave of Amiens, and the choir of Beauvais. The cathedral of Notre-Dame at Paris, though not the first founded, was the earliest in its completion. It was commenced in 1163, the choir was consecrated in 1182, the nave completed in 1208, and the west front in 1223. Thirty years later the transepts were built, and possibly the upper part of the western towers. The chapels outside the nave aisles and between the buttresses were added towards the close of the thirteenth century, and their erection was followed by that of the eastern chapels in the fourteenth.

The cathedral at Rheims was commenced in 1211, and retains its original plan without additions. This consists of nave, transept, and choir, and with side aisles, an apse, and a chevet of five chapels. The term *chevet* is given to the apse when surrounded with a series of chapels beyond the aisle, which is a characteristic feature in French architecture. Its earliest occurrence is found in the church of Notre-Dame du Port at Clermont; and as subsequently developed in the principal French cathedrals, it forms the most beautiful feature in their internal design. We have already noted that it was in the apse of St. Denis the pointed arch first made its appearance, and all the most complicated problems of vaulting would seem to have been solved in the vaulting of the single or double aisles round the apse and the chapels forming the chevet. The chief characteristics of Rheims are the immense solidity of the lower portions of the walls, the simplicity of its plan, and the magnificence of its western porch; unfortunately, before the building had risen much higher than the triforium galleries, the resources began to fail, and the upper parts of the cathedral, though fine in their design and rich in detail, seem wanting in the massiveness and solidity of the lower portion. The porch is the finest of the many glorious examples in France: in this as in other cases the wall is brought out in front of the main walls of the towers, or of the west wall of the nave, so as to form three recesses from ten to twelve feet in depth (very much in the same way as some of our Norman doorways with their series of recessed arches are built out). In these are placed series of life-size figures under rich canopies; above these, from the springing to the apex of the several orders of arches, are placed half-length figures of smaller size also with canopies. Although at first this arrangement of overhanging figures may seem to be a mistake, one's criticism is

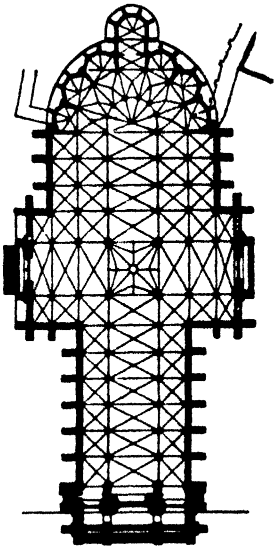


Fig. 32.—The Ground Plan of Amiens Cathedral.

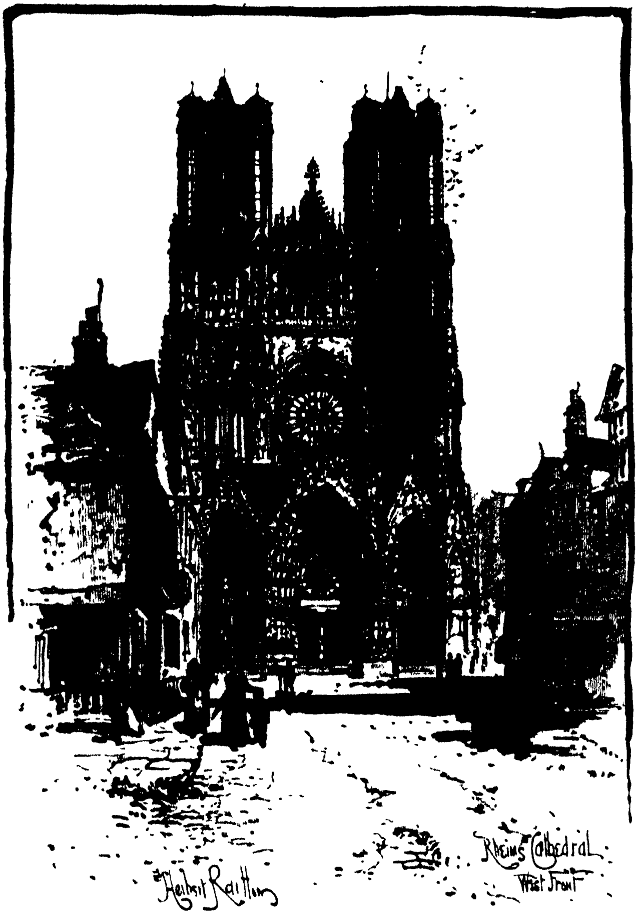


Fig. 83.—Rheims Cathedral.

disarmed by the rich decorative effect and by the beautiful carving of figures and canopies.

Portions of the cathedral of Chartres are of earlier date, the western porch belonging to the first church of the eleventh century; the proportions of the interior are finer in this respect, that there is not the same straining after immense height in comparison with width. The nave is 50 feet wide and 106 feet high to vault, very nearly a proportion of 1 to 2; whereas in Westminster Abbey the width is only 33 feet and the height 90 feet, approaching, therefore, 1 to 3. It is the south-west tower which is looked upon as one of the marvels of French Gothic, and not the north-west tower, which, though of much later date, belonging, in fact, to the last phase of French Gothic—the Flamboyant—is nevertheless a very beautiful conception.

In the cathedral of Amiens, commenced in 1220, the architects were able not only to profit by the experience already gained in the erection of the other cathedrals described, but also to indulge in that scheme of decoration which was beginning to exercise so great a fascination over the builders of churches, and this not only on account of the exquisite beauty of colour but from the opportunity it offered of setting forth the history of the Christian religion. To the invention and employment of stained glass as a means of decoration and as an historical record we owe the traceried window and the full and complete development of the Gothic style; and just as on the exterior, the porch and niches and every available space were filled with sculpture illustrative of Bible history from the Creation of the World, so, in the interior these truths were set forth in painted glass, and all the efforts of the architect were centred in the desire to obtain every portion of the wall that could be made available for the purpose. It is this more than anything else that led to the careful calculation of the thrust of the vault, to its concentration in piers or flying buttresses, and to the ultimate development of the style as we find it in the purer examples of the St. Chapelle, Paris, and St. Ouen, Rouen.

There is still one other earlier building already referred to which in some sense, though incomplete, may be looked upon as the apotheosis of French Gothic, the choir of Beauvais, which has been already noted as one of the four wonders of France. It is possibly in some measure owing to its being only a choir that its magnificence is due, because its great dimension is in one direction, viz., height. The vault rises to the immense height of 156 feet, the piers of the flying buttress alone are over 100 feet in height, and the whole work is built in the most beautiful masonry, with the greatest subtlety of calculation in the piers and buttresses necessary for the support of its vault, so that in the result it can only call forth wonder and admiration of such a majestic work. It is only right, however, to point out that the builders calculated here with too little margin for accident, and already when half built alterations had to be made in the design to give greater stability to the piers.

The ultimate division and subdivision of shafts and ribs, each of which, like the muscles in the human frame, was supposed to exercise free and independent action, ultimately led, in St. Ouen at Rouen, to the vertical lines assuming a tenuity which gave them a wiredrawn effect, and the eye searches in vain for some plain wall-surface for repose, such repose as is given in the simpler and more solid masonry of Chartres, which to the architect conveys a much greater effect of beauty than the too scientific calculations of the St. Chapelle or of St. Ouen. It may have been this sense of too great mathematical accuracy which led the architects of the last phase of French Gothic, the Flamboyant style, to introduce curved lines of various kinds in the tracery of their windows, and to cover the constructive portions of their buildings with elaborate blank tracery of the most beautiful description; or, that having mastered the problems of thrust and counterbalance, the stone-carvers felt themselves free to indulge in that complication of canopy work which forms the chief characteristic of this late period. The church of St. Pierre at Louviers, the tomb of Marguerite de Bourgogne at Brou, the south porch of Albi cathedral, and the Palais de Justice of Rouen, may be taken as examples of the most beautiful and complicated work of this description.

We have hitherto made no mention of the secular or domestic work of the Gothic period, not that examples are not to be found, but because they always followed in the wake of church development. Besides, as a rule, the vault never entered into their construction: *most of the problems the solution of which created the Gothic style, had no existence in domestic work.* The wall surfaces were perfectly plain, or decorated only by bas-reliefs cut in the solid masonry; small string-courses marked the second floor levels, or ran under the window sills; and the windows, according to the period, had either simple, circular, or pointed-headed arches, or, from the thirteenth century, were filled with tracery. In the later periods just as the wall surfaces of the cathedral became covered with blank tracery, so this method of decoration spread to the domestic work, as may be seen in the Palais de Justice at Rouen already referred to. In the same town the Hôtel Bourgtheroulde may be taken as another example, while at Blois in the earlier parts of the Château, and in the Hôtel of Jacques Cœur at Bourges, the last phase of French Gothic is shown in the beautiful canopy work in the tracery of the windows and balustrades. There is one characteristic, however, in which domestic work in France differs from ecclesiastical, and that is in those features which were derived from the military architecture of the middle ages. The towers and walls with their machicolations, such as we find in Carcassonne, and at Pierrefonds and Coucy, became the prototypes of many features we find introduced into the later domestic work, and the towers and turrets of the house of Jacques Cœur at Bourges, which group so picturesquely in the design, are independent of ecclesiastical work, and are the natural descendants of those features which in the feudal châteaux were designed for defence. The machicolations and hoards of the mediæval château became the parapet of the palace or mansion, and the entrance gateway of the mediæval tower or feudal fortress the prototype of the *porte cochere* of the French seigneur's palace of the fifteenth century.

GREEK.—XVII.

[*Continued from p.* 208.]

PARADIGMS OF CONTRACTED VERBS.

ACTIVE VOICE.

INDICATIVE MOOD.

Present Tense.

	CHARACTERISTIC α.	CHARACTERISTIC ε.	CHARACTERISTIC ο.
S.	τιμ(ά-ω)ῶ, *I honour.*	φιλ(έ-ω)ῶ, *I love.*	μισθ(ό-ω)ῶ, *I let.*
	τιμ(ά-εις)ᾷς.	φιλ(έ-εις)εῖς.	μισθ(ό-εις)οῖς.
	τιμ(ά-ει)ᾷ.	φιλ(έ-ει)εῖ.	μισθ(ό-ει)οῖ.
D.	τιμ(ά-ε)ᾶ-τον.	φιλ(έ-ε)εῖ-τον.	μισθ(ό-ε)οῦ-τον.
	τιμ(ά-ε)ᾶ-τον.	φιλ(έ-ε)εῖ-τον.	μισθ(ό-ε)οῦ-τον.
P.	τιμ(ά-ο)ῶ-μεν.	φιλ(έ-ο)οῦ-μεν.	μισθ(ό-ο)οῦ-μεν.
	τιμ(ά-ε)ᾶ-τε.	φιλ(έ-ε)εῖ-τε.	μισθ(ό-ε)οῦ-τε.
	τιμ(ά-ου)ῶ-σι.	φιλ(έ-ου)οῦ-σι.	μισθ(ό-ου)οῦ-σι.
		Imperfect Tense.	
S.	ἐτίμ(α-ον)ων.	ἐφίλ(ε-ον)ουν.	ἐμίσθ(ο-ον)ουν.
	ἐτίμ(α-ες)ας.	ἐφίλ(ε-ες)εις.	ἐμίσθ(ο-ες)ους.
	ἐτίμ(α-ε)α.	ἐφίλ(ε-ε)ει.	ἐμίσθ(ο-ε)ου.
D.	ἐτιμ(ά-ε)ᾶ-τον.	ἐφιλ(έ-ε)εῖ-τον.	ἐμισθ(ό-ε)οῦ-τον.
	ἐτιμ(ά-ε)ά-την.	ἐφιλ(έ-ε)ει-την.	ἐμισθ(ό-ε)ου-την.
P.	ἐτιμ(ά-ο)ῶ-μεν.	ἐφιλ(έ-ο)οῦ-μεν.	ἐμισθ(ό-ο)οῦ-μεν.
	ἐτιμ(ά-ε)ᾶ-τε.	ἐφιλ(έ-ε)εῖ-τε.	ἐμισθ(ό-ε)οῦ-τε.
	ἐτίμ(α-ον)ων.	ἐφίλ(ε-ον)ουν.	ἐμίσθ(ο-ον)ουν.
		Perfect Tense.	
S.	τετίμηκα.	πεφίληκα.	μεμίσθωκα.

(So πεφώρᾶκα, etc.)

Pluperfect Tense.

S.	ἐτετιμήκη.	ἐπεφιλήκη.	ἐμεμισθώκη.

(So ἐπεφωρᾱ́κη, etc.)

Future Tense.

S.	τιμήσω (φωρᾱσω).	φιλήσω.	μισθώσω.

Aorist.

S.	ἐτίμησα, (ἐφώρᾱσα).	ἐφίλησα.	ἐμίσθωσα.

SUBJUNCTIVE MOOD.

Present Tense.

S.	τιμ(ά-ω)ῶ	φιλ(έ-ω)ῶ.	μισθ(ό-ω)ῶ.
	τιμ(ά-ῃς)ᾷς.	φιλ(έ-ῃς)ῇς.	μισθ(ό-ῃς)οῖς.
	τιμ(ά-ῃ)ᾷ.	φιλ(έ-ῃ)ῇ.	μισθ(ό-ῃ)οῖ.
D.	τιμ(ά-η)ᾶ-τον.	φιλ(έ-η)ῆ-τον.	μισθ(ό-η)ῶ-τον.
	τιμ(ά-η)ᾶ-τον.	φιλ(έ-η)ῆ-τον.	μισθ(ο-η)ῶ-τον.
P.	τιμ(ά-ω)ῶ-μεν.	φιλ(έ-ω)ῶ-μεν.	μισθ(ό-ω)ῶ-μεν.
	τιμ(ά-η)ᾶ-τε.	φιλ(έ-η)ῆ-τε.	μισθ(ό-η)ῶ-τε.
	τιμ(ά-ω)ῶ-σι.	φιλ(έ-ω)ῶ-σι.	μισθ(ό-ω)ῶ-σι.

OPTATIVE MOOD.

Present Tense.

S.	τιμ(ά-οι)ῷ-μι.	φιλ(έ-οι)οῖ-μι.	μισθ(ό-οι)οῖ-μι.
	τιμ(ά-οις)ῷς.	φιλ(έ-οις)οῖς.	μισθ(ό-οις)οῖς.
	τιμ(ά-οι)ῷ.	φιλ(έ-οι)οῖ.	μισθ(ό-οι)οῖ.
D.	τιμ(ά-οι)ῷ-τον.	φιλ(έ-οι)οῖ-τον.	μισθ(ό-οῖ)οῖ-τον.
	τιμ(ά-οι)ῴ-την.	φιλ(έ-οι)οί-την.	μισθ(ό-οι)οί-την
P.	τιμ(ά-οι)ῷ-μεν.	φιλ(έ-οι)οῖ-μεν.	μισθ(ό-οι)οῖ-μεν.
	τιμ(ά-οι)ῷ-τε.	φιλ(έ-οι)οῖ-τε.	μισθ(ό-οι)οῖ-τε
	τιμ(ά-οι)ῷ-εν.	φιλ(έ-οι)οῖ-εν.	μισθ(ό-οι)οῖ-εν.

Attic Form.

S.	τιμ(α-οί)ῴ-ην.	φιλ(ε-οί)οί-ην.	μισθ(ο-οί)οί-ην.
	τιμ(α-οί)ῴ-ης.	φιλ(ε-οί)οί-ης.	μισθ(ο-οί)οί-ης.
	τιμ(α-οί)ῴ-η.	φιλ(ε-οί)οί-η.	μισθ(ο-οί)οί-η.
D.	τιμ(α-οί)ῴ-ητον.	φιλ(ε-οί)οί-ητον	μισθ(ο-οί)οί-ητον.
	τιμ(α-οι)ῳ-ήτην.	φιλ(ε-οι)οι-ήτην.	μισθ(ο-οι)οι-ήτην.
P.	τιμ(α-οί)ῴ-ημεν.	φιλ(ε-οί)οί-ημεν.	μισθ(ο-οί)οί-ημεν.
	τιμ(α-οί)ῴ-ητε.	φιλ(ε-οί)οί-ητε.	μισθ(ο-οι)οί-ητε.
	τιμ(ά-οι)ῷ-εν.	φιλ(έ-οι)οῖ-εν.	μισθ(ό-οι)οῖ-εν.

IMPERATIVE MOOD.

Present Tense.

S.	τίμ(α-ε)α.	φίλ(ε-ε)ει.	μίσθ(ο-ε)ου.
	τιμ(α-έ)ά-τω.	φιλ(ε-έ)εί-τω.	μισθ(ο-έ)ού-τω.
D.	τιμ(ά-ε)ᾶ-τον.	φιλ(έ-ε)εῖ-τον.	μισθ(ό-ε)οῦ-τον.
	τιμ(α-έ)ά-των.	φιλ(ε-έ)εί-των.	μισθ(ο-έ)ού-των.
P.	τιμ(ά-ε)ᾶ-τε.	φιλ(έ-ε)εῖ-τε.	μισθ(ό-ε)οῦ-τε.
	τιμ(α-έ)ά-τωσαν or τιμ(α-ό)ώ-ντων.	φιλ(ε-έ)εί-τωσαν or φιλ(ε-ό)ού-ντων.	μισθ(ο-έ)ού-τωσαν or μισθ(ο-ό)ού-ντων.

INFINITIVE MOOD.

Present Tense.

τιμ(ά-ειν)ᾷν.	φιλ(έ-ειν)εῖν.	μισθ(ό-ειν)οῦν.

PARTICIPLE.

N.	τιμ(ά-ων)ῶν.	φιλ(έ-ων)ῶν.	μισθ(ό-ων)ῶν.
	τιμ(ά-ου)ῶ-σα.	φιλ(έ-ου)οῦσα.	μισθ(ό-ου)οῦ-σα.
	τιμ(ά-ον)ῶν.	φιλ(έ-ον)οῦν.	μισθ(ό-ον)οῦν.
G.	τιμ(ά-ο)ῶ-ντος.	φιλ(έ-ο)οῦ-ντος.	μισθ(ό-ο)οῦ-ντος.
	τιμ(α-ού)ώ-σης.	φιλ(ε-ού)ού-σης.	μισθ(ο-ού)ού-σης.
	etc.	etc.	etc.

MIDDLE VOICE.

INDICATIVE MOOD.

Present Tense.

S.	τιμ(ά-ο)ῶ-μαι.	φιλ(έ-ο)οῦ-μαι.	μισθ(ό-ο)οῦ-μαι.
	τιμ(ά-ῃ)ᾷ.	φιλ(έ-ῃ)ῇ.	μισθ(ό-ῃ)οῖ.
	τιμ(ά-ε)ᾶ-ται.	φιλ(έ-ε)εῖ-ται.	μισθ(ό-ε)οῦ-ται.
D.	τιμ(ά-ε)ᾶ-σθον.	φιλ(έ-ε)εῖ-σθον.	μισθ(ό-ε)οῦ-σθον.
	τιμ(ά-ε)ᾶ-σθον.	φιλ(έ-ε)εῖ-σθον.	μισθ(ό-ε)οῦ-σθον.
P.	τιμ(α-ό)ώ-μεθα.	φιλ(ε-ό)ού-μεθα.	μισθ(ο-ό)ού-μεθα.
	τιμ(ά-ε)ᾶ-σθε.	φιλ(έ-ε)εῖ-σθε.	μισθ(ό-ε)οῦ-σθε.
	τιμ(ά-ο)ῶ-νται.	φιλ(έ-ο)οῦ-νται.	μισθ(ό-ο)οῦ-νται.

Imperfect Tense.

S.	ἐτιμ(α-ό)ώ-μην.	ἐφιλ(ε-ό)ού-μην.	ἐμισθ(ο-ό)ού-μην.
	ἐτιμ(ά-ου)ῶ.	ἐφιλ(έ-ου)οῦ.	ἐμισθ(ό-ου)οῦ.
	ἐτιμ(ά-ε)ᾶ-το.	ἐφιλ(έ-ε)εῖ-το.	ἐμισθ(ό-ε)οῦ-το.
D.	ἐτιμ(ά-ε)ᾶ-σθον.	ἐφιλ(έ-ε)εῖ-σθον.	ἐμισθ(ό-ε)οῦ-σθον.
	ἐτιμ(α-έ)ά-σθην.	ἐφιλ(ε-έ)εί-σθην.	ἐμισθ(ο-έ)ού-σθην.
P.	ἐτιμ(α-ό)ώ-μεθα.	ἐφιλ(ε-ό)ού-μεθα.	ἐμισθ(ο-ό)ού-μεθα.
	ἐτιμ(ά-ε)ᾶ-σθε.	ἐφιλ(έ-ε)εῖ-σθε.	ἐμισθ(ό-ε)οῦ-σθε.
	ἐτιμ(ά-ο)ῶ-ντο.	ἐφιλ(έ-ο)οῦ-ντο.	ἐμισθ(ό-ο)οῦ-ντο.

Perfect Tense.

S	τετίμημαι.	πεφίλημαι.	μεμίσθωμαι.

(So πεφώρᾱμαι.)

Pluperfect Tense.

S.	ἐτετιμήμην.	ἐπεφιλήμην.	ἐμεμισθώμην.

(So ἐπεφωρᾱ́μην.)

Future Tense.

S.	τιμήσομαι.	φιλήσομαι.	μισθώσομαι.

(So φωρᾱ́σομαι.)

Aorist.

S.	ἐτιμησάμην.	ἐφιλησάμην.	ἐμισθωσάμην.

(So ἐφωρᾱσάμην.)

Third Future Tense.

S.	τετιμήσομαι.	πεφιλήσομαι.	μεμισθώσομαι.

(So πεφωρᾱ́σομαι.)

SUBJUNCTIVE MOOD.

Present Tense.

S.	τιμ(ά-ω)ῶ-μαι.	φιλ(έ-ω)ῶ-μαι.	μισθ(ό-ω)ῶ-μαι.
	τιμ(ά-ῃ)ᾷ.	φιλ(έ-ῃ)ῇ.	μισθ(ό-ῃ)οῖ.
	τιμ(ά-η)ᾶ-ται.	φιλ(έ-η)ῆ-ται.	μισθ(ό-η)ῶ-ται.
D.	τιμ(ά-η)ᾶ-σθον.	φιλ(έ-η)ῆ-σθον.	μισθ(ό-η)ῶ-σθον.
	τιμ(ά-η)ᾶ-σθον.	φιλ(έ-η)ῆ-σθον.	μισθ(ό-η)ῶ-σθον.
P.	τιμ(α-ώ)ώ-μεθα.	φιλ(ε-ώ)ώ-μεθα.	μισθ(ο-ώ)ώ-μεθα.
	τιμ(ά-η)ᾶ-σθε.	φιλ(έ-η)ῆ-σθε.	μισθ(ό-η)ῶ-σθε.
	τιμ(ά-ω)ῶ-νται.	φιλ(έ-ω)ῶ-νται.	μισθ(ό-ω)ῶ-νται.

OPTATIVE MOOD.

Present Tense.

S.	τιμ(α-οί)ῴ-μην.	φιλ(ε-οί)οί-μην.	μισθ(ο-οί)οί-μην.
	τιμ(ά-οι)ῷ-ο.	φιλ(έ-οι)οῖ-ο.	μισθ(ό-οι)οῖ-ο.
	τιμ(ά-οι)ῷ-το.	φιλ(έ-οι)οῖ-το.	μισθ(ό-οι)οῖ-το.
D.	τιμ(α-οί)ῴ-σθον.	φιλ(έ-οι)οῖ-σθον.	μισθ(ό-οι)οῖ-σθον.
	τιμ(α-οί)ῷ-σθην.	φιλ(ε-οί)οί-σθην.	μισθ(ο-οί)οί-σθην.
P.	τιμ(α-οί)ῴ-μεθα.	φιλ(ε-οί)οί-μεθα.	μισθ(ο-οί)οί-μεθα.
	τιμ(ά-οι)ῷ-σθε.	φιλ(έ-οι)οῖ-σθε.	μισθ(ό-οι)οῖ-σθε.
	τιμ(ά-οι)ῷ-ντο.	φιλ(έ-οι)οῖ-ντο.	μισθ(ό-οι)οῖ-ντο.

IMPERATIVE MOOD.

Present Tense.

S.	τιμ(ά-ου)ῶ.	φιλ(έ-ου)οῦ.	μισθ(ό-ου)οῦ.
	τιμ(α-έ)ά-σθω.	φιλ(ε-έ)εί-σθω.	μισθ(ο-έ)ού-σθω.
D.	τιμ(ά-ε)ᾶ-σθον.	φιλ(έ-ε)εῖ-σθον.	μισθ(ό-ε)οῦ-σθον.
	τιμ(α-έ)ά-σθων.	φιλ(ε-έ)εί-σθων.	μισθ(ο-έ)ού σθων.
P.	τιμ(ά-ε)ᾶ-σθε.	φιλ(έ-ε)εῖ-σθε.	μισθ(ό-ε)οῦ-σθε.
	τιμ(α-έ)ά-σθωσαν or τιμ(α-έ)ά-σθων.	φιλ(ε-έ)εί-σθωσαν or φιλ(ε-έ)εί-σθων.	μισθ(ο-έ)ού-σθωσαν or μισθ(ο-έ)ού-σθων.

INFINITIVE MOOD.

Present Tense.

τιμ(ά-ε)ᾶ-σθαι.	φιλ(έ-ε)εῖ-σθαι.	μισθ(ό-ε)οῦ-σθαι.

PARTICIPLE.

N.	τιμ(α-ό)ώ-μενος.	φιλ(ε-ό)ού-μενος.	μισθ(ο-ό)ού-μενος.
	τιμ(α-ο)ω-μένη.	φιλ(ε-ο)ου-μένη.	μισθ(ο-ο)ου-μένη
	τιμ(α-ό)ώ-μενον.	φιλ(ε-ό)οί-μενον.	μισθ(ο-ό)ού-μενον.
G	τιμ(α-ο)ω-μένου	φιλ(ε-ο)ου-μένου	μισθ(ο-ο)ου-μένου.
	τιμ(α-ο)ω-μένης.	φιλ(ε-ο)ου-μένης.	μισθ(ο-ο)ου-μένης.

PASSIVE VOICE.

Aorist.

S	ἐτιμήθην.	ἐφιλήθην.	ἐμισθώθην.
(So ἐφωρᾶθην.)			

Future Tense.

S.	τιμηθήσομαι.	φιληθήσομαι.	μισθωθήσομαι.
(So φωρᾱθήσομαι)			

VERBAL ADJECTIVES.

Τιμη-τέος, -τέα, -τέον; φωρᾱ-τέος, -τέα, τέον; φιλη-τέος, -τέα, -τέον; μισθω-τέος, -τέα, -τέον.

Remarks on the Contracted Verbs.

Dissyllabic verbs in *-εω* (as πλέω, *I sail; πνέω, I breathe; θέω, I run*, etc.) admit only the contraction in ει (made up of εει or εε), and in all the other forms remain uncontracted, as :—

Active.

Pres. Ind. Πλέω, πλεῖς, πλεῖ, πλέομεν, πλεῖτε, πλέουσι.
Subj. Πλέω, πλέῃς, πλέῃ, πλέωμεν, πλέητε, πλέωσι.
Imper. Πλεῖ. *Inf.* πλεῖν. *Part.* πλέων, πλέουσα, πλέον.
Impf. Ind. Ἔπλεον, ἔπλεις, ἔπλει, ἐπλέομεν, ἐπλεῖτε, ἔπλεον.
Opt. Πλέοιμι, πλέοις, πλέοι, etc

Middle.

Pres. Ind. Πλέομαι, πλέῃ, πλεῖται, πλεόμεθα, πλεῖσθον, etc.
Inf. Πλεῖσθαι. *Part.* πλεόμενος. *Impf.* ἐπλεόμην.

The verb δέω, *I bind*, admits contraction in all its forms—*e.g.*, δοὺν, δοῦντος, διαδοῦμαι, κατέδουν; but not δεῖ, *it is necessary*, nor δέομαι, *I need*.

Several verbs in *-αω* depart in contraction from the ordinary rules, so that αε, αει, αη, αῃ become η and ῃ instead of α and ᾳ, as :—ζάω, ζῶ, *I live*, ζῇς, -ῇ, -ῆτον, -ῆτε; inf. ζῆν; imperat. ζῆ; imperf. ἔζων, -ης, -η, -ῆτον, -ήτην, -ῶμεν, -ῆτε, -ωσι. Also πεινά-ω, πεινῶ, *I am hungry*, inf. πεινῆν, etc.; διψά-ω, διψῶ, *I am thirsty*, inf. διψῆν. Further, κνάω, κνῶ, *I scratch*, inf. κνῆν; σμάω, σμῶ, *I wash*, inf. σμῆν; ψάω, ψῶ, *I rub*, inf. ψῆν; χράομαι, χρῶμαι, *I use, need*, χρῇ, χρῆται, inf. χρῆσθαι. So ἀποχρῶμαι, *I waste*, inf. ἀποχρῆσθαι; χράω, χρῶ, *I give an oracle*, χρῇς, χρῇ, inf χρῆν.

Respecting the use of the Attic forms of the optative in *-ην*, observe that in the singular of the verbs in *-έω* and *-όω* the form *-οίην* is preferable to the ordinary form, and in the verbs in *-άω* is almost exclusively to be employed; but in the dual and the plural the ordinary form in all three kinds of verbs is more usual. The third person plural has regularly the shorter form.

State what is the part, and what is the English, of the words in the following exercise :—

Ἐτιμήσα. ἐμισθώθην. φιλητέος. τετίμηκα. τιμητέος. τιμῷμι. φιλοῖεν. τιμῴμην. τιμῴμεθα. τιμῷ. τιμῷεν. μισθοῖτε. ἐτίμα. ἐφίλει. ἐμισθοῦ. ἐφιλεῖτο. μισθοῦτο. ἐτιμῶμεν. ἐφιλεῖτε. ἐμισθοῦτε. ἐτιμᾶσθε. ἐμισθοῦσθε. τιμῶν. τιμῶσα. φιλοῦντος. τιμωμένη. φιλουμένου. μισθοῦσθαι. μισθοῖ. φιλῶμαι. φιλοῦμαι. φιλῇ. φιλεῖσθαι.

Give the contracted form for these uncontracted forms :—

Τιμάεις. φιλέω. τιμάετε. τίμαε. φιλέομεν. τιμάουσι. ἐμίσθοε. ἐτιμάεσθον. ἐφιλεόμην. ἐμισθόετο. μισθοόμενος. τιμάοιεν. φιλέοιμεν. μισθόοι. μισθόοιμι. τιμάοιτο. μισθόοιντο τιμαοίημεν. φιλεοίην. μισθοοίητον. μισθοοίητε. φιλέοιντο.

Write out in full, according to the paradigms, the following verbs, first in an uncontracted form, and then in a contracted form, and then again in the two forms combined :—

Φοβέω, *I frighten*, φοβήσω, πεφόβηκα, πεφόβημαι.
Χωρέω, *I yield*, χωρήσω, κεχώρηκα, κεχώρημαι.

Ποιέω, *I make*, ποιήσω, πεποίηκα, πεποίημαι.
Ἀγαπάω, *I love*, ἀγαπήσω, ἠγάπηκα, ἠγάπημαι.
Νικάω, *I conquer*, νικήσω, νενίκηκα, νενίκημαι.
Δηλόω, *I show*, δηλώσω, δεδήλωκα, δεδήλωμαι.
Χρυσόω, *I gild*, χρυσώσω, κεχρύσωκα, κεχρύσωμαι.

In order to obtain a perfect acquaintance with these verbs, we must practise the forms in detail, and first

THE PRESENT AND IMPERFECT ACTIVE OF CONTRACTED VERBS IN -*άω*.

VOCABULARY.

Ἀγαπάω, I love.
Ἀκμή, -ῆς, ἡ, the height, the bloom *or* flower (our *acmé*).
Ἀστράπτω, I lighten (it lightens).
Βροντάω, I thunder.
Δράω, I do.
Ἑλλάς, -άδος, ἡ, Hellas, Greece.
Ἐξαπατάω, I deceive.
Ἡλικία, -ας, ἡ, age.
Θαῤῥαλέως, daringly, bravely.
Ἰδέα, -ας, ἡ, appearance, form.
Καί, even.
Νικάω, I conquer.
Ὁράω, I see.
Ὁρμάω, I set out, rush.
Σιωπάω, I am silent.
Συγκυκάω, I mix together, put in confusion (*κυκάω*, I move, mix).
Σύμμαχος, -ον, fighting with (on the side of). As a substantive, *an ally*.
Τελευτάω, I end (life), die.

EXERCISE 89.

Translate into English :—

1. Πολλάκις γνώμην ἐξαπατῶσιν ἰδέαι. 2. Μὴ σὲ νικάτω κέρδος. 3. Ἐρῶ τῆς ἀρετῆς. 4. Πολλάκις νικᾷ καὶ κακὸς ἄνδρα ἀγαθόν. 5. Οἱ ἀγαθοὶ ἐρῶσι τῆς 6. Πολλοὶ ἄνθρωποι ἐν τῇ τῆς ἡλικίας ἀκμῇ τε- 7. Ἢ σιώπα, ἢ λέγε ἀμείνονα. 8. Ἀνάγκη ἐστὶ πάντας ἀνθρώπους τελευτᾶν. 9. Νοῦς ὁρᾷ καὶ νοῦς ἀκούει. 10. Θαῤῥαλέως, ὦ στρατιῶται, ὁρμῶμεν ἐπὶ οὺς. 11. Πρὶν μὲν πεινῆν πολλοὶ ἐσθίουσι, ῆν πίνουσιν. 12. Οὐκ ἔστι τοῖς μὴ δρῶσι ύχη. 13. Περικλῆς ἤστραπτεν, ἐβρόντα, συνεκύκα τὴν Ἑλλάδα. 14. Εἴθε πάντες παῖδες τοὺς γονεῖς ἀγαπῷεν.

QUESTIONS ON THE EXERCISE.

What is ἐξαπατῶσιν made up of? What mood, tense, and person is it? What class of verbs does it belong to?

Why is ἡλικίας in the genitive case? Go through the noun—that is, decline it.

Give the tense to which ὁρᾷ belongs, in all its parts—first uncontracted, then contracted.

What part of the verb is δρῶσι?

What is the root of ἤστραπτεν? What augment has the form?

Explain the formation of συνεκύκα.

What part of the verb is ἀγαπῷεν? Go through the tense.

EXERCISE 90.

Translate into Greek :—

1. Thou deceivest. 2. He deceives. 3. He was deceiving. 4. You two deceive. 5. They deceive. 6. They were conquering. 7. We were conquering. 8. The general conquers all his enemies. 9. I am hungry. 10. We are thirsty. 11. They are hungry. 12. The allies are hungry. 13. It lightens. 14. It thunders. 15. Thou didst put the city in confusion. 16. Good children love their parents. 17. The boy loves his mother. 18. Thou lovest all men. 19. They see thee.

THE PRESENT AND IMPERFECT ACTIVE OF CONTRACTED VERBS IN -*έω*.

VOCABULARY.

Ἀθυμέω, I am dispirited (*θύμος*, spirit, courage).
Ἀμελέω, I neglect, disregard.
Ἂν, *short for* ἐάν (with subjunctive mood) *καὶ ἂν* = *κἂν*
Ἀποῤῥέω, I flow from.
Ἀσκέω, I practise, exercise.
Δέω (with gen.), I want; **δεῖ**, it is necessary (with acc. and inf.).
Δυστυχέω, I am unfortunate.
Ἐθέλω *or* **θέλω**, I wish, I will.
Ἐπαινέω, I praise.
Εὐτυχέω, I am fortunate, prosper.
Εὐχή, -ῆς, ἡ, a request, prayer.
Κρατέω (with gen.), I command (*κράτος*, strength), am master of.
Λαλέω, I speak.
Μάλα, greatly, much; *compar.* *μᾶλλον*, rather (in Latin *magis*, *potius*); *superl.* *μάλιστα*, *maxime*, very much, perfectly.
Οὐδέποτε, never.
Οὔτε — οὔτε, neither — nor.
Ποιέω, I make, I do; hence *ποιήτης*, a poet—that is, *a maker* or *inventor*.
Πονέω, I labour.
Προσδοκάω, I expect, look for.
Σιγάω, I am silent.
Συλλαμβάνω, I take with, I help (governs the dative).
Συμπονέω, I labour with, assist.
Τελέω, I bring to an end, accomplish.
Φρονέω, I have in my mind, I mind; *μέγα φρονεῖν*, to be haughty.

EXERCISE 91.

Translate into English :—

1. Ἀνὴρ πονηρὸς δυστυχεῖ, κἂν εὐτυχῇ. 2. Βίος κράτιστος (sc. ἐστὶ) ἂν θύμου κρατῇς. 3. Σιγᾷν μᾶλλον ἢ λαλεῖν πρέπει. 4. Ὅ τι ἂν ποιῆτε, νομίζετε ὁρᾷν Θεόν. 5. Φίλος φίλῳ συμπονῶν αὑτῷ πονεῖ. 6. Οἱ ἄνθρωποι θνητοὶ μὴ φρονούντων ὑπὲρ θεούς. 7. Ὁ μάλιστα εὐτυχῶν μὴ μέγα φρονείτω. 8. Οὐδέποτ' ἀθυμεῖν τὸν κακῶς πράττοντα δεῖ, τὰ βελτίω δὲ προσ-

δοκεῖν ἀεί. 9. *Τῷ πονοῦντι Θεὸς συλλαμβάνει.* 10. *Δικαιοσύνην ἀσκεῖτε καὶ ἔργῳ καὶ λόγῳ.*

EXERCISE 92.

Translate into Greek :—

1. He is unfortunate. 2. They are fortunate. 3. They were fortunate, but they were not happy. 4. You are unfortunate. 5. Conquer your spirit. 6. Friends work together with (dat.) friends. 7. Let not a mortal man think (*carry his aims*) above the gods. 8. They become dispirited when they are unfortunate. 9. Ye are dispirited. 10. He was dispirited. 11. The boy neglected his body. 12. A wise man praises those who practise justice.

KEY TO EXERCISES.

Ex. 87.—1. The soldiers were ordered to go against the enemy. 2. Sparta was once fearfully shaken by an earthquake. 3. The power of the Persians has been broken by the Greeks. 4. The enemy were shut up in the citadel. 5. The barbarians took to flight when they heard the Greeks dash their shields against their spears 6. The war was stopped. 7 We hope that we shall accomplish all things well. 8. I would that I might accomplish all things well. 9. The treaty has been broken by the barbarians.

Ex. 88.—1. Οἱ *στρατιῶται πρὸς τοὺς πολεμιους πορεύεσθαι κεκελευσμένοι εἰσιν.* 2. Ἡ *πόλις ἡμετερα ὑπὸ σεισμοῦ τέθραυσται.* 3 Ἐκεινη *ἡ πόλις ὑπὸ σεισμοῦ θραυσθησεται.* 4. Ἡ *πολις ὑπὸ σεισμοῦ σειεται* 5. Ἡ *τῶν Περσῶν δύναμις ὑπὸ τῶν* Ἑλληνων *ἐθραύσθη.* 6. Οἱ *πολεμιοι εἰς τὴν ἄκραν κατακεκλεισμένοι εἰσίν.* 7. Αἱ *ἀσπίδες πρὸς τὰ δόρατα ὑπὸ τῶν πολεμιων ἐκρούσθησαν.* 8. Ὁ *πόλεμος πεπαυται.* 9. Ὁ *πόλεμος πεπαύσεται.* 10. Εἴθε *πάντα καλῶς ἀνυσαιμεθα.* 11. Κελεῦσαι *ῥᾴδιόν ἐστιν ἢ ἀνυσαι.* 12. Ἡ *συνθήκη ὑπὸ τῶν πολεμιων λυθησεται.*

POLITICAL ECONOMY.—IV.

[*Continued from p. 212.*]

LAND, LABOUR AND CAPITAL (*continued*).

LET us look at some of the circumstances by which the productive power of land has been increased :—

(1) The improvement of breeds of domestic animals by careful selection of the best stock; and also of seed.

(2) In hot countries, the storage of water and irrigation of land; which we know to have been practised at least 1,000 years B.C.

(3) Rotation of crops, to use all the different substances in the ground that plants require. The gradual disintegration of rock, and the action of water in carrying these substances goes far in course of time to replace those used.

(4) New kinds of crops. Maize, introduced into Italy in the fifteenth century, is now the staple food in much of that country. Buckwheat seems to have come into Europe with some of the various invasions of barbarians from the East. It is not mentioned before the fifteenth century. Rice was introduced into Spain from Africa by the Moors; the Arab conquest of Egypt had introduced it there from Asia. In the fifteenth century it was introduced into Italy, and it is now a staple food in parts of the north. Now these two latter grains will grow plentifully on land which (because it is too poor in the first case, and too wet in the second) would not grow wheat at all, or not nearly so much. More food is therefore produced with less labour, and some labour is set free to produce other things. Still more striking is this in the case of potatoes. To grow potatoes instead of wheat will enable between five and six times as much food per acre to be produced. Potatoes were introduced from America by Sir Walter Raleigh; but were not generally grown till the last century. It is true this cheapening of staple food has sometimes had one most disastrous result. Population has increased up to the limit of the means of subsistence: then when this cheap food failed, there was nothing else to turn to that could be grown in quantities sufficient for the population. Hence the great Irish famine of 1847.

Much the larger number of the vegetables now grown by English farmers and gardeners—even if we do not count what are grown as mere curiosities—have been introduced in England since the middle ages. Rye-grass, lucerne, kohl rabi, and cultivated furze for cattle food, are quite modern crops. Among root crops, turnips and mangelwurzel were introduced into England from Holland about the sixteenth century. At first they were only known as garden plants, but in the seventeenth century they came to be very generally planted on land which had hitherto lain fallow for the year. In the eighteenth century there was a great increase of cattle food, owing to the fact that clover and lucerne began to be much cultivated and manuring became much more general. So we find a striking contrast between the quantity and quality of meat available in the middle ages and in the present day. In the fourteenth century a fat bullock, ready to kill, seldom weighed more than 400 lb. In the sixteenth now and then it seems to have weighed 600. Scientific cattle breeding began about the middle of the last century, and the best bullocks of many breeds now weigh over 2,000 lb. This is due partly to better feeding, partly to more care in breeding; and of course the larger the size of the animal, the greater the proportion of meat to "offal." Since about 1800, oil-cake, ensilage, and other cattle foods have come in to assist in increasing the weight, and indeed in keeping cattle alive through the winter. In the middle ages people never had fresh meat in winter, because, having only hay, they could not afford to feed their cattle well enough to make it worth while to keep them. They killed and salted them in the autumn, except a few, and lived on salt meat, of course without vegetables—whence in part the terrible scurvy or "leprosy" which has left so many traces in the "lazar houses" of old English towns, and the "squints" or "leper holes" found in some old English churches. Again, in the fourteenth century the fleece of a sheep probably weighed about 1½ lb. on the average: the wool was very coarse and poor. In the eighteenth century it weighed 5 lb., now it may be from 7 to 9 lb. The fat sheep too has increased from an average weight of 40 lb. in thirteenth-century England to 70 or 80 lb. or more (according to the breed) to-day.

New methods of tillage—manuring, subsoil ploughing, machine cultivation, and so on—have also done much to increase the productive power of land. In the fourteenth century, the average produce of English corn land in a good year was about 11 bushels per acre. The average now is 25 to 27 bushels, which but for the low price of wheat due to foreign competition, might easily be increased to 35; while in some cases 50 to 52 bushels an acre is produced. The grain too weighs more and is much more nutritious than in the fourteenth century.

In manufacture the great development of machinery, dating from about 120 years ago, has immensely increased the productive power of labour; while the working power of the labourer has been immensely increased by his better food, his better sanitary surroundings, and his greater education, both at school and by the increased variety of his ordinary life. High wages, themselves the result of increased production, spontaneously react to produce an increase through producing these effects. It must not be supposed that this productive power is capable of indefinite increase, or that it is always increased by the same methods. In some branches of industry, notably in vine-growing, and some kinds of fruit and vegetable culture, the small farmer can actually beat the large company, though it has plenty of capital and the latest appliances. They cannot supervise their men so efficiently; and as he gets all the product he does not care how hard he works.

DISTRIBUTION.—(A) THE LANDLORD'S SHARE.

Assuming, then, that land is private property, and that landlord, labourer, and capitalist are separate persons, what will be the shares of each in the product? What will the landowner receive simply as a landowner, whether he also works or supplies capital or does neither?

Economists, in answering this question, make the following assumptions: (1) Land varies in fertility and convenience of situation, and in other advantages, such as healthiness, which we may for brevity class under one of these heads. (2) At any given time, there is some land being cultivated which will only just pay for cultivation: that is to say, will give the cultivator the ordinary rate of profit on his capital besides replacing what he expends on it. Land which does not do this would, of course, soon ruin the cultivator unless he had other means of living; and unless he gets about as much as he would in some other business, we may assume he will not care to continue working his land. Many people no doubt—some country gentlemen, for instance—cultivate land which does not pay them; but then their chief aim in doing so is not the production of wealth, but amusement or occupation: so they are outside the province of political economy. (3) As the better land will produce more for the cultivator, men with capital will be constantly bidding against each other for land; and the landlords will stand out for the highest rent they can get. (4) Competition is perfect: that is, each landlord knows what offers are being made for the various descriptions of land, and each would-be tenant knows the qualities of each lot of land and can accurately estimate its worth. This last assumption is clearly never realised, but it gives us an idea of what the landlord's share *tends to be* apart from the complications introduced by ignorance, imperfect competition, and various non-commercial causes.

Now it is clear that a would-be tenant cannot profitably offer to pay anything for the use of the land just "on the margin." This would reduce his profits, so that his farming would no longer pay. But let us suppose that such land produces (say) fifteen bushels of wheat per acre; and that the intending farmer sees a piece which he thinks would produce twenty bushels. Clearly, he can make just the same profit by taking this land and paying the landlord the equivalent of five bushels, as he would by taking the poorer land. As a matter of fact, he may very likely expect that the landlord will, to get his land let, refrain from exacting quite all the value of five bushels. But assuming that the landlord does exact all, clearly the highest rent the tenant can afford is the equivalent of five bushels an acre. If one tenant does not offer that, another will; while if one landlord asks six bushels' rent for land that will produce only five bushels beyond the fifteen which represent the cost of production *plus* the ordinary profit, the competition of other landlords with him for tenants will bring down this figure. Finally, the land on the margin of cultivation will just pay expenses but leave no surplus, and the rent that can be paid for any other piece will be just equivalent to the excess of its produce over that of the land "on the margin of cultivation."

When the soil of England supplied nearly all the grain consumed in the country, the rise or fall of this margin of cultivation could be seen in some districts. On Salisbury Plain, for instance, it is said, when the price of grain was expected to be high, fresh land would be taken into cultivation. When the price of grain fell again, such land went out of cultivation and became pasture. Now that foreign grain has largely displaced English, the margin has ascended in England—that is, it does not pay to cultivate some of the land which was formerly profitable. But, as a rule, the margin constantly descends, because population constantly increases and more food is wanted for them. Railways and steamers have made it possible to get at the grain from new countries whose fertility and situation (in the economic sense) are superior to that of England. But the supply of fresh land is by no means infinite, and these temporary disturbing causes do not permanently affect the truth of the theory.

But it must be admitted that history does not seem to bear out the theory entirely. We should expect, according to it, that the most fertile lands would be cultivated first, and that as the demand for food increased with the increase of population, less and less fertile land would be gradually resorted to. But, as a matter of fact, we find that cultivation has very often begun among the mountains, in relatively poor land, and has gradually spread down to the plains; because a nation must be strongly organised for defence before it can cultivate land exposed to an enemy. In America, too, the rich bottom land along the great river valleys is by no means all cultivated even now; because it requires much capital and labour to protect it against floods or to make it healthy enough for labourers to work there. And the lands of the new countries opened up in this century—American prairies, Australia, the wheat lands of Manitoba, and of the Argentine Republic—are not less but more fertile than English land: true, they mostly produce about three-fifths or four-fifths the amount per acre that average English land produces, but they do so at much less cost. But, really, all this is not against the theory. The Law of Rent, like other laws of abstract science, is true, provided the assumptions from which it follows are true and are not complicated in practice by special facts. As a matter of fact, they always are complicated by some such facts. The wheat lands of America have only been opened up recently, because, until railways and steamers were running, the wheat could not be taken away. As it is, much fertile land has been added to the available food area; and what is the consequence? English rents have gone down—just as they ought according to the theory. Some of the objections, too, overlook the fact that political economy has to use ordinary words in special senses. "Fertility and situation" mean in connection with the theory, "advantageousness for cultivation"; and the rich unhealthy land we spoke of, though "fertile" enough in the ordinary sense, is not fertile in this special sense of political economy.

This same law of rent applies—with a slight change, of course, in the meaning of the terms—to mines, fisheries, quarries, and all sources of wealth the output from which is not capable of indefinite increase; or which, as it is sometimes put, are subject to the Law of Diminishing Returns—that is, from which an increased quantity of wealth can only be got by a more than proportionate increase of the cost of getting it, *i.e.*, of the labour and capital applied to the land. Manufactured goods are not (appreciably) subject to this law, because, though their raw material is so, the cost of it is so small a part of the total cost of the finished product that we may disregard the increased cost, due to the law, in our calculations. But it is clear that if we have to dig deeper for our coal, for instance, the difficulty of working it will increase very rapidly; and we should presently come to a limit of depth beyond which it would be unprofitable, and even physically impossible, to pass.

The law of rent also applies to the rent of freehold building land, and that part of house rent which represents the payment for the land as distinct from the payment for the use of the house; this latter part, it is to be particularly noted, is to be classed as interest on the capital of the house-owner. Here we may, in stating the law, write "advantageousness" or "productivity" instead of "fertility and situation." In London and many parts of England, the land, and the houses on it, so often belong to different owners, that the distinction is clear enough.

Now supposing (for simplicity) that a people lived on an island quite cut off from the rest of the world, it is clear that their land would tend to increase in value without anything being done to it, simply because there would be more and more demand for the limited quantity of land available, to grow food or for building. And a little reflection will show us that as population constantly tends to increase, this value must constantly tend to increase too. There may, of course, be exceptions—population may move away from one district where work is slack or the soil or climate bad, to another with less disadvantage in these respects; or a large area of fertile land may be very rapidly opened up—as in Western North America since about 1840. But these clearly are *exceptions*. In our great towns land is constantly becoming more and more valuable on the whole, simply because more people wish for houses and shops in town, and so with the increased demand the value rises.

This increase of value, due as it is to the circumstances of the society, not to anything the landlord does, has been called the "unearned increment"—a term invented by J. S. Mill; and it has been proposed to tax it heavily, or deprive the landlords of it altogether. This question we must reserve until we talk about taxation. Other kinds of wealth of course often increase in value, without the owner or indeed anyone having done anything to them; but the conditions under which they do so are more various and less common.

From the law of rent a curious result follows—that rent is not an element in the price of the product, provided that competition is perfect. For some land produces only just enough to pay working expenses, with a profit; the producer must sell his grain at a certain price to make it worth his while to grow any. If he reduces his price appreciably, he will soon have to go out of the trade. Now why should the producers from better land take any price less than this? If competition is perfect, the buyers' competition will send up the prices of the produce from the better land to the level of the prices of the produce from the worst. So that were the cultivators of this better land its owners, they would of course get larger profits on their capital than the cultivators of the worst do; but the consumer would pay the same price for produce of the same quality, whatever land it came from. But assuming that the cultivators hire their land, they will offer some part of these extra profits to the landlords, as rent of the better land; and as competition becomes more and more perfect, they will tend to offer the whole. With absolutely perfect competition, such as the theory assumes for convenience, they would offer the whole.

Hence, anything that artificially increases the price of agricultural produce to the consumer—such as a duty on foreign corn—must eventually tend to benefit the landlord, rather than the tenant. The law of rent is usually treated with reference to agricultural produce alone. From the tenant's standpoint, we see it is a price paid for a natural advantage. From the landlord's standpoint, it is a surplus that the possession of a natural advantage enables him to secure. And the price of agricultural produce generally tends to be fixed by the price of that portion of it which just covers the cost of production (including the average rate of profit).

It has recently been noticed that all these propositions are true of other kinds of produce. Special advantages in production, or special business ability,* tend to get extra remuneration for their owner which is of the nature of a price paid for a natural advantage. And the price of all produce tends to be fixed by the price of that portion which is produced at the least advantage. But so many more causes complicate these tendencies in manufacture and trade than in agriculture that they have only recently been noticed in the former, and the results are as yet but little worked out.

(B) THE LABOURER'S SHARE.

A builder about to contract to build a house may be supposed to estimate his expenses somewhat thus:—So much for materials; so much for cartage; so much for wear and tear of machinery or of tools which he may supply; so much for labour; and he would add a sum which is his profit. The person for whom the house is to be built might analyse the price he pays under these heads. Contractor's profit and workmen's wages seem to him part of the expenses of production; while to the contractor the wages he pays, at any rate, seem to be so.

If we look at the transaction more broadly, however, the cost of production is here confused with the remuneration of the different people employed. From the point of view of society generally, master and workmen are working together in building a house. The master consumes his capital in a way that affords him no present enjoyment. The political economist's concise name for this use of capital is "abstinence." The master and the workmen both give their labour, and in the result there is one house more added to the sum of wealth in the world. Clearly, if the workmen could have waited to draw their wages in a lump, master and workmen would then be dividing (according to stipulated shares) the equivalent of the wealth they had been producing. The workmen would get the reward of their labour; the master of his "abstinence," as defined above, and of his labour of superintendence and his risks.

The old analysis of cost of production—which included wages and profits in it—confused "reward" with "cost." Profits are not "cost" except from the purchaser's point of view; wages are "cost" only from the purchaser's or employer's. Both, in reality, are shares of the product. But as it is generally quite impossible to say exactly what the product will fetch when it is completed, still more what share each man has taken in producing it, wages are advanced to the workmen out of capital, and the capitalist repays himself out of the price he gets for the product. The money wages now paid are partly, at least, a sort of rough composition for the workman's share of the product.

This arrangement is only possible where there is plenty of capital. In new countries, where capital is scarce, it often does not exist. Farm hands in many parts of the United States usually live with their employer. He boards and lodges them, and advances money to them from time to time. But they do not get all their wages for the year till the chief crop for the year is sold: that is to say, their wages are paid out of the product, but advances are previously made out of capital, and the employer repays himself out of the product. Only within the last thirty years has this system declined in the eastern and middle states, with the growth of capital and of facilities for borrowing; and it is said still to be common in parts of the west.

The dependence of the wages in a trade on the product and its price is admitted by the institution of the "sliding scales" used in some trades, as in the coal and iron trades of the north of England. According to these schemes, wages in the various branches of the trade rise and fall in certain proportions, according as the price of coal and iron rises or falls. But these scales have been tried several times and again abandoned, and it may be feared that the multitude of business details that must be attended to in fixing them can hardly yet be dealt with in a way that satisfies all parties concerned.

This error of including wages in cost of production led to a very unfortunate theory, which embittered the working men of England against political economy more than anything else during the first half of this century. Each employer, it was argued, pays so much wages in a given time, say a year, to his men out of his capital. In different trades a different proportion of capital is paid as wages; the more hand-labour, of course, the greater the proportion. But the proportion in each trade is fixed by the circumstances of that trade—the amount of capital in it, the kind of work done, etc. The capital in each trade devoted to the payment of wages was called a wage-fund. Now suppose the workmen in a trade ask for more wages. If the masters pay more, it will reduce their rate of profit; then it may not be worth their while to continue in the trade. Moreover, if wages rise in a trade, fresh men naturally will come in, so each workman will get a smaller share of the wage-fund. So that in any trade, at any time, each man's rate of wages is fixed by the conditions of production. If the rate rises, capital will leave the trade and the total wage-fund will be diminished, and fresh men will come in; so the wage per head will be diminished too.

This theory comes down from the beginning of this century, when English trade was rapidly increasing, hand-labour was still much used, capital did not move so freely into prosperous trades as it does now (since there were fewer banking facilities and much less capital to lend); and so the first question a manufacturer asked himself when he wanted to increase his production was, Have I enough capital to put on more hands? But it entirely overlooks two facts:—(1) That the product and the value of the product are not fixed quantities in manufacture any more than in agriculture. More might be turned out and yet less profit made, or *vice versâ*. A sudden demand for coal in 1873 (owing partly to the opening of the Suez Canal, and to the increase from that and other causes of steam navigation, iron, and other manufactures) sent up the price of coal, the profits of the coal owners, and the miners' wages all together—and the rise in wages was not all due to the fact that the supply of skilled miners ran short. (2) That, as a matter of fact, the rate of profit does not depend on wages; that it did was a corollary from this "wage-fund" theory. If the product and its value were fixed quantities, and the "wage-fund" was fixed too, it followed that wages could only be increased by taking from profits, and *vice versâ*. In reality, however, it is indicated by many observations that it is truer to say that "the rate of profit depends on the cost of labour"—which is a very different thing from the rate of wages. Many proofs that the highest paid labour is often the cheapest have been collected by Lord Brassey from the books of a firm of railway contractors, which his father founded, and he has published them in a book called "Work and Wages." The firm made many railways in many countries, and had great opportunities of estimating the different capacities of English, Irish, French, Hindoo, and other navvies. They found that the highest paid labourers produced more work in a given time, in proportion to their pay, than the less well paid did; and that an increase of pay—whether by drawing in a better class of men, or by enabling the men to get more nutritious food—often produced a more than proportionate increase of product. Thus, in 1842, on the Paris and Rouen railway, English, French, and Irish quarrymen worked side by side. The Englishmen were paid six francs (about 5s.) a day, the Irish four francs, and the French three francs. Yet, of the three, the Englishmen did the most work in proportion to their pay. In building a refreshment room at an English station, a London bricklayer worked on one side at 5s. 6d. a day, two countrymen on the other at 3s. 6d. Yet the London man, "without undue exertion," did more work in a day than the other two together.

This leads us to a distinction of extreme importance—that between Nominal (or Money) Wages

and Real Wages. Nominal Wages are the labourer's earnings in money. Real Wages are the goods he buys with that money. It is these which constitute the "real reward of the labourer." Thus, real wages depend on the purchasing power of money. Suppose that food, clothing, and houseroom—which are the chief things on which money wages are spent—suddenly doubled in price; it is clear that a weekly wage of £1 would buy little more than a weekly wage of 10s. before the rise. In controversies about Protective tariffs, especially just now in the United States, people are apt to forget this distinction. We shall return to this later.

The wages, then, of a productive labourer are essentially *a share in the product* of his labour—generally but not always advanced long before the product is ready; and their possible limit is fixed by (among a variety of other conditions) the exchange value of the product when complete.

But why do workers in different trades or employments get paid at different rates? (We here use "wages" to include *all* payment for labour or service.) Adam Smith enumerated five causes, "arising from the nature of the employments themselves," viz.: "the agreeableness or disagreeableness of the employment," "the ease or difficulty of learning it," "the constancy or inconstancy of employment," "the degree of trust which must be placed in the person employed," and "the probability or improbability of success." Only the last of these requires a word of explanation. When there is a great inequality between the annual gains of different workers in the same employment, it is to a great extent due to differences of skill, but to some extent also to luck. Some men get plenty of work, and corresponding pay; others, perhaps as well able to do the work, get little or none of either. Now the large gains made by the lucky men impress the imagination, and draw more men in than the employment can support. The profession of a barrister in England is the best instance of this kind, though there are other reasons why it is overcrowded. Adam Smith noticed also that some inequalities, as between different employments, had been caused by the action of Government. Thus the Statute of Apprenticeship, forbidding any master in certain trades to take more than a certain number of apprentices, and preventing men who had not served an apprenticeship from being engaged as journeymen, necessarily limited the supply of labour and kept up wages in those trades. So, too, the Laws of Settlement, preventing any workman who migrated to a place from acquiring a right to poor relief there except under very stringent restrictions, checked the migration of workmen to places where their services were wanted; while (to take a modern instance), on the other hand, the increase of State-aided education in England just after 1870 greatly reduced the salaries paid to ordinary clerks. Again, endowed schools and universities, as Adam Smith noticed, probably tend to reduce the salaries of some kinds of educated labour.

It will easily be seen that all these causes act by affecting the *supply* of labour. And it often happens that some of the least pleasant trades are very badly paid, because they are overcrowded by a number of people who can find no other employment, and are, as a body, inefficient workers. The wages paid to men doing the same kind of work at the same place and time tend, of course, to be fixed by competition. Sometimes, however, they are fixed by custom. A medical man, a barrister, a solicitor, usually gets a certain fee for work of a certain kind, whether his skill is greater or less, and it is not thought proper for him to try and undersell his competitors. In these cases, competition comes in, not to reduce the amount of each fee, but to make a difference in the number of fees gained by the men who are thought most highly of. It is "competition *for* the field of employment" as contrasted with the competition *in* the field which we get (*e.g.*) between rival tradesmen trying to undersell one another.

Now it is quite possible that there may be so many workmen competing for employment in a trade that the share of each in the product may be a very small one. And this leads us to a wider question: How is the rate of wages in general affected by the increase of population?

The theory of population now usually accepted as a theory—though it is much disputed whether special causes will not hinder it from being realised till a very remote period—has been one of the most important parts of political economy.

Briefly, it is this. We find by observation that population tends to multiply—that is, to double itself in varying periods, longer or shorter. Every plant and every animal has far greater power of multiplication than it can use. The elephant, says Darwin in the "Origin of Species," is the slowest breeder of all known animals. Let us assume (what is under the mark) that it breeds between the ages of thirty and ninety, and has three pairs of young meanwhile. Were there no checks—want of food, beasts of prey, disease, etc.—the elephants descended from one single pair, after five centuries, might amount to fifteen millions. It was the observation of this process through all nature that led Darwin to his theory of *natural selection.* Many more animals of all sorts are born than can possibly survive; there is a constant struggle for life going on, and those survive which can manage best to adapt themselves to their conditions.

APPLIED MECHANICS.—XII.

[Continued from p. 217.]

KINETIC ENERGY OF ROTATING BODIES—THE FUNCTION OF A FLY-WHEEL—DETERMINATION OF THE SIZE OF FLY-WHEEL REQUIRED FOR A GIVEN PURPOSE—PRACTICAL ILLUSTRATIONS AND EXAMPLES.

WE have seen that a body moving with what may be called a *linear* motion, that is, as a ship or train usually moves, possesses a store of energy in virtue of its motion, the amount of this store being computed by multiplying half the mass of the body by the square of its velocity. Bodies rotating about an axis as a fly-wheel does, *i.e.*, moving with a rotational or *angular* motion, also possess a similar store of energy, and in this lesson the method of calculating its amount will be discussed. First of all, the question may be asked, why do we put a fly-wheel on an engine or machine? The reply is, to act as a storehouse of energy, so that if a great demand at any particular time should be made, the fly-wheel may be drawn upon to supply the energy which is required *in excess* of that otherwise provided. Just for a similar reason we put a tank for water in a house, so that by a comparatively small supply we may be able to meet a considerable demand for a short space of time. In the case of a steam engine—or better still, a gas engine—the working fluid (steam or gas) gives energy to the piston and fly-wheel only during a short portion of every one or two revolutions, whilst the demand for energy may be fairly steady. If there were no fly-wheel, the driven machines would sometimes have too much and sometimes too little energy supplied to them, and hence their motion would be unsteady.

Similarly, if we have an intermittent *demand*, it can be met with the help of the energy contained in the fly-wheel; in fact, nearly all good systems for the transmission of power have some sort of *accumulator* or storehouse of energy included in the system. In giving out energy the fly-wheel diminishes in speed, and the main question we have to deal with in the design of a fly-wheel for any specified purpose is the amount of energy the fly-wheel can give out without diminishing its speed of rotation below a certain limit; or, what is the same thing, what amount of energy can it receive without increasing in speed *above* a fixed value?

In computing the kinetic energy stored up in any rotating body we can imagine the body divided up into a large number of little portions, and if we could obtain the kinetic energy of each little portion, and leave no portion of the wheel out, the sum of all these energies would be the kinetic energy of the whole wheel. Unfortunately, the difficulty at once presents itself that the velocity of each little portion is different from that of any other which is at a different distance from the axis, and as the velocity enters into the expression for the kinetic energy of each, the calculation presents great complexity. However, there is *one* thing all the little masses possess in common, they have all the same *angular* velocity, *i.e.*, they make the same number of turns per second. It is evident that we must express the kinetic energy of each in terms of the *angular* velocity.

The connection between the two kinds of velocity will readily be understood from Fig. 72. Here a small body is supposed to rotate about an axis at O, following the path C B, and C B is supposed to represent the *distance* the body goes in one second or its linear velocity v. But a radius O C describes the angle A (or C O B) in the same time, hence this angle represents the *angular* velocity A of the body. The student is probably aware that the best way to measure any angle is to divide the arc subtending it by the radius of this arc, hence the angle

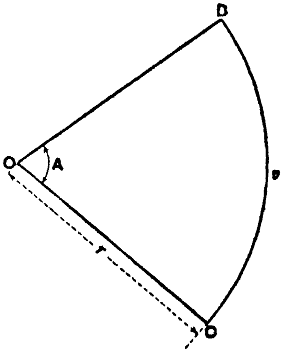


Fig. 72.

$$A = \frac{\text{arc B C}}{\text{radius O C}} = \frac{v}{r} \text{ or } v = Ar.$$

Hence linear velocity is equal to angular velocity × radius. Now the kinetic energy of each little mass is $\frac{1}{2}mv^2$, if m is its mass and v its linear velocity, which for our purpose is better written

$$\tfrac{1}{2} m A^2 r^2,$$

the sum of all such terms, including every little portion of the rotating body, is the kinetic energy of the whole body. Taking the symbol Σ to represent "the sum of all such terms," we have,

$$\text{Kinetic energy of rotating body} = \Sigma \tfrac{1}{2} m A^2 r^2.$$

or since A is the same for all, this expression may be written

$$\tfrac{1}{2} A^2 \Sigma m r^2.$$

Now the expression Σmr^2, representing the sum of all terms obtained by multiplying each little mass in a body by the square of its distance from the axis, is called the *moment of inertia* of the body about that axis. This moment of inertia is generally denoted by the letter I; it has been calculated for us by mathematicians for a great number of regular bodies. We find then that the kinetic energy of a rotating body, like a fly-wheel, is given by the expression $\frac{1}{2}IA^2$, or is *half the product of the moment of inertia of the body and the square of its angular velocity in radians per second.* In calculating the moment of inertia one foot should be taken as the unit of length, the product $\frac{1}{2}IA^2$ will then give the energy in foot-pounds.

Notice the similarity of this expression to that for the kinetic energy of a body moving with a linear motion.

Engineers and practical students whose knowledge of mathematics is limited are generally shy of such expressions as *moment of inertia*; hence it occurred to Professor Perry some years ago to put the expression for the energy of a rotating body in a simpler form. It is evident that the moment of inertia of a body is always the same about the same axis, and also that the angular velocity of the body in radians per second is proportional to the number of revolutions it makes per minute, hence the kinetic energy of any rotating body is *simply proportional to the square of the number of turns it makes per minute*, or what is the same thing, is equal to this square multiplied by a number which is constant for the same body.

It is evident, then, that we can put the result already obtained in the form

$$\text{Kinetic energy of rotating body} = Mn^2,$$

where n is the number of revolutions the body makes per minute, and M is the constant referred to above. To find the meaning of this M, we have only to imagine the body making one turn per minute, and then we see that the M of a rotating body is a number representing the *kinetic energy stored in it when it revolves once per minute.*

In order to find the connection between the M of a body and its moment of inertia, it is only necessary to equate the two expressions for kinetic energy, and remembering that angular velocity,

$$A = \frac{2\pi n}{60},$$

we have

$$M = \frac{\pi^2 I}{1800}.$$

The M of any body is easily calculated thus if its moment of inertia is known. The professor has, however, shown how the M may be obtained by *experiment*, and this is a matter of great importance, as it is difficult to calculate the moment of inertia of such a body as a fly-wheel with any great degree of accuracy.

This experimental method will be explained presently. We wish now to point out the connection between the M's of bodies of the same shape but differing in size.

SIMILAR BODIES ROTATING ABOUT SIMILARLY PLACED AXES.

If we have two similar bodies of the same material rotating about similarly placed axes as shown in Fig. 73, one body being s times the other in every linear dimension, then a little mass m in the smaller will correspond to a mass s^3m in the larger. This will readily be understood by imagining s to be 2, or one body to be twice the other in linear dimensions, then the mass or weight of the larger will evidently be 2^3 or eight times that of the smaller, and the weights or masses of corresponding *little* masses will follow the same rule.

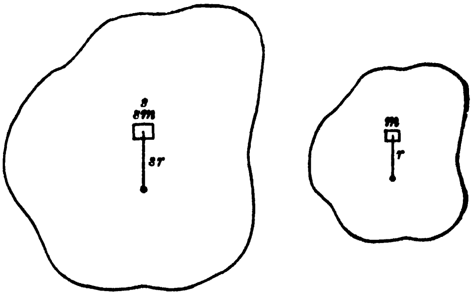


Fig. 73

The moment of inertia I of the smaller body is

$$\Sigma mr^2,$$

and that of the larger I_2 is

$$\Sigma s^3m\,(sr)^2 = s^5\Sigma mr^2,$$

hence we see that bodies like these have moments of inertia about similarly placed axes, *which are as the fifth power of the ratio of their like dimensions.* Since the M of each body is equal to its moment of inertia multiplied by the square of 3·1416 and divided by 1800, it is evident that M is simply proportional to I, and that the rule just obtained must hold if we substitute the M of each body for its moment of inertia; or, in other words, the M's of two similar fly-wheels, for instance, are in the ratio of the fifth powers of their diameters. This rule is of great importance, and will be referred to later on. The student should carefully distinguish between the M of a body and its *mass*, and remember the definition of the former given above.

EXPERIMENTAL DETERMINATIONS.

If we give a measured amount of energy to a fly-wheel and notice the speed of the wheel at any particular instant due to that energy, its M will be found by *dividing* the known kinetic energy by the square of the speed of the wheel in revolutions per minute.

Suppose a fly-wheel—preferably a small one—to be mounted as shown in Fig. 74, the friction at the pivots being diminished as much as possible; then if a weight of W lb. be attached to a cord which is wound round the axle, it is evident that when W is allowed to fall h feet (there being h feet of cord wound on) it gives to the fly-wheel energy approximately equal to the potential energy, Wh foot-pounds, which it has lost. If, for instance, W is 40 lb., and there are 6 feet of cord wound on the axle at the beginning, then if W is allowed to fall it loses 40 × 6 or 240 foot-pounds of potential energy, the greater part of which is given to the wheel. It is only just at the instant at which the cord leaves the axle that this energy may be fairly represented as stored in the wheel—for every turn the wheel makes after that an amount of energy is wasted in overcoming frictional and other resistances. The question then arises, how may the speed of the wheel *just at the proper instant* be found?

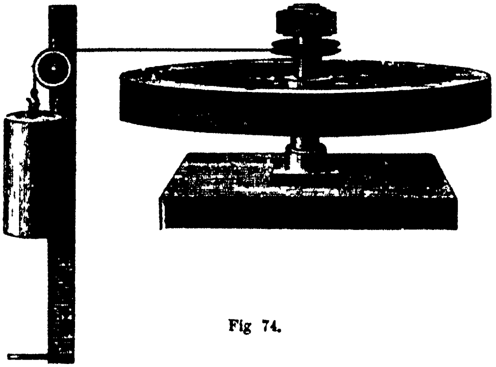


Fig 74.

A very good speed-indicator if suddenly attached and detached might do, or some sort of indicator which would show the *maximum* speed attained; but it is questionable if such an indicator could be found. However, if we may assume that the force of friction is fairly constant, we know that the motion of the wheel is uniformly accelerated, gradually increasing to a certain maximum value—which is required—and then gradually diminishing till the wheel comes to rest. If we find the *average* speed of the wheel from the instant the weight begins to act till it is released, double this average speed will be the highest speed required.

If, for example, the cord is wound 10 times round the axle at the beginning, then if the weight acts on the wheel for 5 seconds, the *average* speed of the wheel during this time is $\frac{10}{5}$, or 2 revolutions per second, and the highest speed attained is 4 revolutions per second, or 240 revolutions per minute. If the weight is 40 pounds, and the fall 6 feet as before, then, neglecting certain sources of waste of energy, we have

$$40 \times 6 = \text{M} \times 240^2, \text{ or M} = \frac{1}{240} = \cdot 004;$$

and the wheel is such that it contains a store of ·004 foot-pounds of energy when rotating at the very slow speed of 1 revolution per minute. If the wheel at any time rotates, say, at 100 revolutions per minute, its kinetic energy is

$$\cdot 004 \times 100^2 = 40 \text{ foot-pounds.}$$

There are, however, certain corrections which ought to be made. The kinetic energy of the falling weight itself is *not* given to the wheel and must be subtracted from the potential energy, in this case 240 foot-pounds, lost. This kinetic energy is half the mass of the acting weight multiplied by the square of its linear velocity in feet per second *just at the instant its cord is released from the axle*, which may be found from its mean velocity as already indicated.

Again, the friction at the bearings of the fixed pulley wastes energy. The friction can be found by an experiment similar to that described at page 81, and the waste of energy calculated. In this case, however, the student will do well to remember that if a weight of W pounds is hung from the cord which embraces only *one quarter* of the circumference of the pulley, the resultant load on the pulley is $\sqrt{2} \times$ W instead of 2W as in the case referred to at page 31. The energy wasted at the pivots of the wheel is the last correction we shall refer to. This may be found approximately by counting the number of revolutions the wheel makes *after* the weight ceases to act on it, knowing the total energy dissipated, the energy wasted per revolution, and hence that wasted *whilst the weight acted* can be found.

We have not space to refer to other minor corrections.

The question now arises, having found our M, what practical use do we make of the result? A practical example will be the best answer to this question. Suppose we are designing the fly-wheel for a gas-engine—say of the Otto type—and we want the fly-wheel to be in every respect similar to that to which we have referred above, the corrected M of which is, say, ·003, and the diameter of which is 2 feet. We must be given the limiting speeds of the new wheel and the power developed by the engine. Let the limiting speeds be 149 and 151 revolutions per minute, and the power of the engine 12 horse power. The fly-wheel will be designed, in this case, simply with regard to the *engine itself*, fluctuations of load being left out of account. The Otto engine completes its cycle of operations, from the in-drawing of gas into the cylinder till its expulsion after having completed its work, in *two* revolutions of the crank shaft or fly-wheel. But the gas gives energy to the fly-wheel only during a quarter of this cycle, hence we may say that, approximately, all the energy required during the remaining three-quarters of the cycle must be stored in, and unstored from, the fly-wheel.

The engine develops

$$12 \times 33000 \text{ foot-pounds of energy per minute,}$$

hence the work of one cycle is

$$\frac{12 \times 33000 \times 2}{150} \text{ foot-pounds,}$$

and the work to be stored is three-quarters of this. This energy must be absorbed by the fly-wheel, whilst its speed increases from 149 to 151 revolutions per minute, and must be given out again with a similar but diminishing change of speed. The energy in the fly-wheel when rotating at 151 revolutions per minute is equal to its M multiplied by the square of 151, and similarly its store at the lower speed is M multiplied by the square of 149. The difference of these two amounts is the whole store of energy given out whilst the speed falls from 151 to 149.

Hence

$$\tfrac{3}{4} \times \frac{12 \times 33000 \times 2}{150} = M(151^2 - 149^2).$$

which gives the M of the new wheel = 6·6.

Recalling the rule that the M's of two similar bodies rotating about similarly placed axes are as *the fifth powers of their like dimensions*, and representing the diameter of the new wheel by D, we have

$$\frac{6·6}{·003} = \frac{D^5}{2^5}, \text{ or } D = 2\sqrt[5]{\frac{6·6}{.003}},$$
$$= 2 \times 4·661 = 9·32 \text{ feet}$$

The new wheel must, therefore, be 9·32 feet in diameter, or in other words, every linear dimension of the new wheel must be 4·66 times that of the corresponding wheel with which the experiment was carried out. The required wheel may be made from the drawings of the smaller one by simply increasing the scale of the drawing 4·66 times. In practice it is more usual to put *two* fly-wheels on a gas-engine than to make one of such a large diameter.

NUMERICAL EXAMPLES.

1. If the moment of inertia of a fly-wheel with a *thin* rim be taken as approximately equal to the mass of the rim multiplied by the square of its mean radius, find the M of a fly-wheel the rim of which weighs 10 tons and has a mean radius of 5 feet. Answer, M = 95·36.

2. A fly-wheel is required which is to have a kinetic store of energy of 1,000 foot-pounds when rotating 20 times per minute, and which is to be similar to an existing wheel which contains a store of 8,000 foot-pounds when rotating 30 times per minute. Find how many times the diameter of the new wheel must be greater than that of the old.

Answer, $\sqrt[5]{\frac{8·89}{2·5}}$ or 1·29 times.

3. The moment of inertia of a cylinder of length l feet and diameter d feet, about its axis, is $wld^4 \times ·00305$, where w is the weight in pounds of one cubic foot of the material of which the cylinder is composed. From these data find the kinetic energy of a grindstone 6 feet in diameter and 9 inches broad which rotates 75 times per minute. A cubic foot of the material weighs 133⅓ lb.

Answer, 12189·4 foot-pounds.

4. If the axle of the grindstone is 2 inches in diameter at the bearings, and the coefficient of friction between the axle and bearing ·089, how long will it take friction to stop the stone when left to itself as it is rotating at the above speed?

Answer, 2·4 minutes.

ITALIAN.—XI.

[*Continued from p. 225.*]

IMPERSONAL VERBS.

IMPERSONAL verbs only express an indeterminate or uncertain subject or cause of some act. They are conjugated throughout all moods and tenses only in the third person, which is alone capable of conveying the idea of an indeterminate or uncertain subject. There are *three* classes of impersonal verbs in Italian. The *first* are impersonal verbs in the strictest sense of the word, expressing some act which is never attributed to a person, but to some unknown agency. In English they require the indeterminate and neuter pronoun *it*, in Italian they generally require no pronoun whatever, for example:—

Accádo, Avviêne, Occórre,	*it happens.*
Albéggia,	*the day dawns.*
Baléna, Lampéggia,	*it lightens.*
Básta,	*it is enough*
Bisógna,*	*it must, it is necessary.*
Non bisógna, Non occórre,	*there is no need or occasion, it is not necessary.*
Mi cále,	*I care* or *am concerned for, I take an interest in.*
Conviéne,	*it is right* or *proper.*
Dilúvia,	*it rains as fast as it can pour.*
Gêla,	*it freezes.*
Grándina,	*it hails.*
Impôrta,	*it is of importance* or *consequence, it matters.*
Non impórta,	*it is no matter, it does not signify.*
Névica,	*it snows.*
Páre,	*it appears.*
Piôve,	*it rains.*
Piovíggina,	*it drizzles.*
Sémbra,	*it seems.*
Tempésta,	*it is stormy.*
Tuôna,	*it thunders.*

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* This important verb governs an infinitive without a preposition, or *che* with the subjunctive, as *bi-só-gna di-re*, it must be said; *bi-só-gna fáre il sú-o do-vé-re*, one must do one's duty;

Some phrases which in English have *it is*, *it was*, etc., in Italian are expressed by *fa*, it makes; *fa-cé-va*, it made, etc., with some noun or adjective, and must be considered as impersonal periphrases. For example:—

Fa d'uôpo, *or* è d'uôpo, *it is needful.*
Fa cáldo, caldíssimo, *it is hot, very hot.*
Ôggi fa fréddo, *to-day it is cold.*

The impersonal verbs of this class have only the third person singular. But whenever the sense of the impersonal verbs of this class admits of nouns or pronouns becoming their subjects, they must agree with them in number and person; as *gli ôc-chi suô-i lam-peg-giá-va-no*, his eyes sparkled; *le lá-gri-me piô-vo-no dá-gli ôc-chi*, tears flow from the eyes; *gê-la-no i fiú-mi*, the rivers are freezing.

Piô-ve-re, to rain, may be taken as a model of the conjugation of the verbs of this class.

INDEFINITE MOOD.

Present.—Piòvere, *to rain.*
Past.—Aver piovuto, *to have rained.*
Past Participle.—Piovuto, *rained*
Present Gerund.—Piovèndo, *raining.*

INDICATIVE MOOD.

Present.—Piòve, *it rains.*
Imperfect.— Pioveva, *it rained.*
Indeterminate Preterite.—Piovve *or* Piovè *or* piòbbe, *it rained.*
Determinate Preterite.—Ha piovuto,* *it has rained.*
Indeterminate Pluperfect.—Avéva piovuto, *it had rained.*
Determinate Pluperfect.—Èbbe piovuto, *it had rained*
Future.—Pioverà, *it will rain.*
Future Perfect.—Avrà piovúto, *it will have rained*
Conditional Present—Pioverébbe, *it would rain.*
Conditional Past.—Avrèbbe piovuto, *it would have rained.*

SUBJUNCTIVE MOOD.

Present.—Piôva, *it may rain.*
Imperfect.—Piovésse, *it might rain.*
Perfect.—Ábbia piovuto, *it may have rained.*
Pluperfect.—Avesse piovúto, *it might have rained.*

The *second* class are impersonal verbs, *not in the proper sense*, for, being in themselves personal and active, the pronoun *si* makes them (as it were) impersonal, by expressing their subject as an indeterminate person. In English *si* is equivalent to *one*, *people*, *they*, etc.; or also to the passive voice, for example:—

Si díce, *one says, people say, they say, it is said.*
Si créde, *they believe, it is believed.*
Si spêra, *they hope, it is hoped.*

bi-só-gna che ciò si-a vé-ro, this must be true (that is, it is necessary that this should be true; and in all cases where *bisogna* is followed by *che*, the English nominative of *must* is in Italian the nominative of the subjunctive); *bi-só-gna che i-o me ne vá-da*, I must go away; *bi-só-gna ch'égli vén-ga*, he must come, etc. Sometimes, however, it is preceded by the conjunctive pronouns *mi*, *ti*, etc., and loses its characteristic of impersonal by agreeing in number with the noun that follows, as, *mi bi-só-gna da-ná-ro*, I want money; *vi bi-so-gne-rà da-ná-ro*, you will want, need, or require money; *mi bi-só-gna-no da-ná-ri*, I want money, etc.

When the object of these verbs is expressed, *they must agree with it in number and gender*. For example:—

Si vedono molti forestiêri, *one sees many foreigners.*
Si sono vedúti mólti soldáti, *so many soldiers have been seen.*

The irregular verb *dire*, to say, may serve as an example of the conjugation of the second class of impersonal verbs.

INDICATIVE MOOD.

Present.—Si dice; si dicono, *it is said*
Imperfect.—Si diceva; si dicevano, *it was said.*
Indeterminate Preterite—Si disse; si dissero, *it was said.*
Determinate Preterite.—Si e detto; si son détti, *it has been said.*
Indeterminate Pluperfect.—S'èra détto; s'èran détti, *it had been said.*
Determinate Pluperfect.—Si fu détto, si furon dètti, *it had been said.*
Future.—Si dirà; si diranno, *it will be said.*
Future Perfect.—Si sara détto; si saránno détti, *it will have been said.*
Conditional Present.—Si dirèbbe; si dirêbbero, *it would be said.*
Conditional Past.—Si sarebbe detto; si sarébbero détti, *it would have been said.*

SUBJUNCTIVE MOOD.

Present.—Si dica; si dicano, *it may be said.*
Imperfect.—Si dicesse; si dicessero, *it might be said.*
Perfect—Si sia detto; si sian detti, *it may have been said.*
Pluperfect—Si fosse detto; si fossero détti, *it might have been said*

The *third* class of impersonal verbs consists of reflective verbs used impersonally. They require the pronouns *mi*, me, *or* to me; *ti*, thee, *or* to thee; *gli*, him, *or* to him; *le*, her, *or* to her; *ci*, us, *or*, to us; *vi*, you, *or* to you, generally to be placed *before*, and *ló-ro* them, *or* to them, *after* the verb. They invariably have the third person, which must be plural when a plural object of the verb is named. For example:—

Mi rincrésce, *it displeases me (I am sorry, displeased, annoyed).*
Ti rincrésce, *it displeases thee (thou art sorry, etc.).*
Gli rincresce, *it displeases him (he is sorry, etc).*
Le rincrésce, *it displeases her (she is sorry, etc.)*
Ci rincresce, *it displeases us (we are sorry, etc).*
Vi rincrésce. *it displeases you (you are sorry, etc.)*
Rincresce lóro, *it displeases them (they are sorry, etc.).*
M'accade,
M'avviène, } *it happens to me.*
M'occórre,
Mi básta, *it is enough for me.*
Mi bisógna, *it behoves me, I want, need,* or *must.*
Mi conviene, *it behoves me, I must.*
Mi páre, *it appears to me.*
Mi sémbra, *it seems to me.*
Non vi rincresca, signóre, di aspettare un tantíno, *be pleased, sir, to wait a little.*

The irregular verb *mi di-spiá-ce*, it displeases me, *or* I am sorry, may be taken as an example:—

INDICATIVE MOOD.

Present.—Mi dispiáce, *it displeases me, I am sorry, etc.*
Imperfect.—Mi dispiacéva, *it displeased me, I was sorry, etc.*
Indeterminate Preterite.—Mi dispiácque, *it displeased me, I was sorry, etc.*

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* Impersonal verbs relating to the weather may take either *avere* or *essere* in their compound tenses.

Determinate Preterite.—Mi è dispiaciúto, *it has displeased me, I have been sorry, etc.*

Indeterminate Pluperfect.—Mi èra dispiaciúto, *it had displeased me, I had been sorry, etc.*

Future – Mi displacerà, *it will displease me, I shall be sorry, etc.*

Conditional Present.—Mi displacerébbe, *it would displease me, I should be sorry, etc*

IMPERATIVE MOOD.

Displácciati, *may it displease thee, be thou sorry, etc.*

SUBJUNCTIVE MOOD.

Present.—Mi displáccia, *it may displease me, I may be sorry, etc.*

Imperfect.—Mi displacésse, *it might displease me, I might be sorry, etc.*

And so on with the other tenses.

With regard to all classes of impersonal verbs, it may be stated that *egli* is occasionally found before them, which, however, in these cases is merely an elegant expletive.

With regard to the impersonal verbs which require the plural of the third person when a plural object is named, it may be added that a merely indirect connection of a plural object with a verb—for example, by means of the genitive case – cannot come under this rule, and leaves the singular of the third person unchanged, as *si pár-la di guèr-re*, they talk of wars; *si di-scór-re dél-le có-se pas-sá-te*, they discourse upon things past.

INTRANSITIVE OR NEUTER VERBS

These verbs require no other case but the nominative to form a complete sentence, for their subjects act on no objects: for example, *Ot-tó-ne non dor-mí-va*, Otho did not sleep; *é-gli è già ri-tor-ná-to*, he has already returned. Active verbs which either govern the accusative case (as, *é-gli ha scrít-to mól-te lèt-te-re*, he has written many letters; *noi ab-biá-mo ven-dú-to i ca-vál-li*, we have sold the horses), or which, governing no accusative, require a supplementary word in the genitive, dative, or ablative case, to complete their meaning (as, *par-lá-va di al-cú-ni af-fá-ri*, he spoke of several affairs), take the auxiliary *avere* in their compound tenses. Of neuter verbs, on the other hand, some take *essere*, some *avere*, and some both these auxiliaries, in their compound tenses. Use, however, will be the best and safest guide. Here are some neuter verbs which, in English as well as in Italian, require the auxiliary *avere*, to have.—

Dormire, *to sleep.*	Hô dormito, *I have slept.*
Bére, *to drink.*	Hô bevúto, *I have drunk.*
Pranzáre, *to dine.*	Hô pranzáto, *I have dined.*
Cenáre, *to eat supper.*	Hô cenáto, *I have eaten supper.*
Ridere, *to laugh*	Hô riso, *I have laughed.*
Piángere, *to shed tears.*	Hô pianto, *I have shed tears.*
Giocáre, *to play.*	Hô giocáto, *I have played.*

Neuter verbs requiring *essere* for their compound tenses principally are those which denote motion, or some change which allows the subject to be considered in a passive state. Here are some examples:—

Andáre, *to go.*	Sóno andáto.
Apparíre, *to appear.*	„ appárso.
Arriváre, *to arrive.*	„ arriváto.
Caláre, *to go down.*	„ caláto.
Convenire, *to agree.*	„ convenúto.
Créscere, *to grow.*	„ cresciúto.
Divenire, diventáre, *to become.*	„ divenúto, diventáto.
Entrare, *to come in.*	„ entráto.
Giúgnere, *to arrive at.*	„ giúnto.
Impallidíre, *to get pale.*	„ impallidíto.
Impazzíre, *to go mad.*	„ impazzíto.
Intervenire, *to intervene.*	„ intervenúto.
Náscere, *to originate, arise, be born.*	„ náto.
Partíre, *to set out.*	„ partíto.
Passáre, *to pass.*	„ passato.
Perire, *to perish.*	„ períto
Pervenire, *to attain to, arrive at.*	„ pervenúto.
Rimanére, *to stay, remain behind*	„ rimásto *or* rimáso.
Ritornáre, rivenire, *to return, come again.*	„ ritornáto, rivenúto.
Salíre, *to ascend, to mount.*	„ salíto.
Scappáre, *to escape.*	„ scappáto.
Scéndere, *to descend, come* or *go down.*	„ sceso.
Sopragiugnere, *to supervene, happen unexpectedly.*	„ „ sopragiúnto.
Sortíre, *to sally, make a sortie, to go out.*	„ sortíto.
Stáre, *to stand*	„ státo.
Tornáre, *to return, begin* or *become again, turn, turn out.*	„ tornáto.
Venire, *to come*	„ venúto.
Uscíre, *to go* or *come out.*	„ uscíto.

The past participle of neuter verbs conjugated by *essere* must agree in number and gender with the subject or nominative to which it relates. For example —

Le donne sóno andáte a cá-sa, ma gli uómini sóno restáti, *the women have gone home, but the men have remained.*

The participle, however, of neuter verbs conjugated by *avere* remains unchanged.

Neuter verbs conjugated by both *essere* and *avere* are—

Camminàre, *to travel, walk.*	Sono *and* hô camminàto.
Correre, *to run.*	„ hô córso.
Dimoráre, *to dwell, stay*	„ hô dimoráto.
Fuggíre, *to fly, shun, run away.*	„ hô fuggíto.
Vivere, *to live.*	„ hô vissúto.

Neuter verbs requiring the auxiliary *essere*, when they take a reflective form and meaning, must retain it in their compound tenses for example, *sono andato*, I have gone, and *me ne sono andato*, I have gone away. But neuter verbs conjugated by *avere* must drop this auxiliary and take *essere* whenever, with conjunctive pronouns, they become reflective verbs: for example, *rí-de-re*, to laugh, has *hô ri-so*, I have laughed; while *rí-der-si di ú-no*, to laugh at one, has *mi só-no rí-so di lui*, I have laughed at him, etc.

VOCABULARY.

Abito, coat, dress.
Adoprare, to use, employ.
Allegro, cheerful.
Alle sette, at seven o'clock.
Alle tre, at three o'clock.
Aprire, to open.
Bocca, mouth.
Borsa, purse.
Braccio (pl. *braccia*), arm, cubit.
Camera, chamber, room.
Canzone, song, ballad.
Ciarlare, to prattle.
Comandare, to command, order.
Contenere, to contain, hold.
Costare, to cost.
Dormire, to sleep.
Fanciullo, young child, little boy.

Gli uni—gli altri, some—and others.
Guadagnare, to win, gain.
Guanto, glove.
Imparare, to learn.
Lezione, lesson.
Lodare, to praise.
Loro, there.
Maestro, master, teacher.
Mano, hand.
Mentrechè, while, whilst.
Meritare, to merit, deserve.
Moneta d'oro, gold coin.
Non—niente, nothing.
Nuovo, new.
Ordinariamente, usually.
Paio, pair, couple.
Panno, cloth, woollen cloth.
Parecchi, *-chie*, several.
Parlare, to speak, talk.
Passeggiare, to take a walk.
Perchè, because, for, why?
Perdere, to lose.
Pigro, idle.
Pranzare, to dine.
Quando, when.
Quanto, how much.
Ragazzo, *ragazza*, boy, girl
Raramente, rarely, seldom.
Recare, to bring, fetch, carry.
Regola, rule.
Riflettere, to reflect.
Ripetere, to repeat, say over again.
Suonare, to play upon, sound.
Tanto tempo quanto, (as) so long as.
Tardare, to tarry, delay.
Trovare, to find.
Ubbidire, to obey, be obedient.
Vecchio, old man.

EXERCISE 34.

Translate into English .—

1. Í-o pas-ség-gio ó-gni giór-no ál-le sêt-te. 2. Qué-sti guán-ti cô-sta-no dú-e scel-lí-ni. 3. Fí-gli ub-bi-diên-ti mê-ri-ta-no l'a-mó-re de' ló-ro ge-ni-tó-ri. 4. Il fan-ciúl-lo ri-flêt-te ra-ra-mén-te. 5. Gli ú-ni pêr-do-no, gli ál-tri gua-dá-gna-no. 6. Qué-sti ra-gáz-zi ri-pê-to-no la ló-ro le-zió-ne, men-tre-chè qué-ste ra-gáz-ze ciár-la-no. 7. Gl'In-glé-si á-pro-no ap-pé-na la bóc-ca quán-do pár-la-no. 8. An-tô-nio ha tro-vá-to ú-na bór-sa che con-te-né-va pa-réc-chie mo-né-te d'ô-ro 9 Tu sê-i al-lé-gro, per-chè il maê-stro ti lo-dò 10. Suo-ná-i iê-ri il pia-no-fôr-te, e mi-a so-rêl-la can-tò ú-na nuô-va can-zó-ne.

VOCABULARY.

A cavallo, on horseback.
Adunque, then, therefore.
Ai nove, on the ninth.
Avvertire, to advise, inform.
Azione, action, deed.
Circostanza, circumstance.
Cominciare,* to begin, commence.
Compagnia, company, party.
Conto, account (*rendere conto di*, to give an account of).
Diligenza, diligence, care.
Ella,† you.
Fico, fig.
Finire, to finish
Giovanni, John.
Impedire, to impede, hinder, prevent.
Invitare, to invite.
Mal di denti, toothache.
Mandare, to send.
Mangiare,‡ to eat.
Negligenza, negligence.
Numeroso, numerous.
Obbligare, to oblige, compel.
Oriuolaio, watchmaker.
Orologio, clock, watch.
Pensare, to think.
Pietro, Peter
Pipa, tobacco-pipe.
Portare, to carry, bring.
Pranzo, dinner.
Prendere (past part. *preso*), to take.
Presto, soon.
Rendere, to send or give back again, restore, repay
Riparare, to repair.
Rispondere, to answer, reply.
Saluto, salute, bow (*rendere il saluto*, to return one's salute, bow).
Schiuma di mare, meerschaum
Studiare, to study.
Susina, *pera*, *pomo*, plum, pear, apple.
Tutto quello che, all that.
Una volta, once.
Uscire, to go out.
Va, goes.
Veramente, truly, indeed.
Vorrei, I should wish (from *volere*).

EXERCISE 35.

Translate into Italian :—

1. Mr. N. has invited me to dinner; I think I shall find there a large party. 2. Will you go out on horseback to-day? 3. My sisters will soon arrive. 4. Peter will return to you all that he has taken. 5. Once we shall render an account of our actions. 6. I will answer your letter on the ninth of this month. 7. When will you leave off? 8. I should have finished already if you had not hindered me. 9. Leave off, then. 10. If you really loved the Italian language, you would study it with more diligence. 11. I (should) wish that you would finish the work which you have begun. 12. John brings plums, pears, and apples.

VOCABULARY.

Abbandonare, to abandon, forsake.
Ad alta voce, loud
Annoiarsi, to feel annoyed.
Bellissimo, very beautiful
Biasimare, to blame.
Certamente, certainly
Cogliere (past part, *colto*), to gather
Condiscepolo, schoolfellow.
Defunto, deceased, late
Delizioso, delicious
Disegnare, to design, draw.
Dovere, must, ought, be obliged.
Enrichetta, Harriet.
Federico, Frederick.
Figura, figure, form.
Fragola, strawberry.
Giusto, just, right.
Glieli,§ them to him.
Intendere, to understand, hear.
Legare, to bind
Legatore di libri, bookbinder.
Mandare, to send
Merito, merit, desert, reward.
Mondo, world.
Odiare, to hate
Onorare, to honour.
Premiare, to reward.
Punire, to punish.
Qui, here.
Tema, exercise (on a rule of grammar).
Trattare, to treat, use.
Uccello, bird.
Virtuoso, virtuous, upright.

EXERCISE 36.

Translate into Italian :—

1 Returning to the house, I have found your brother 2 Not speaking Italian, you must feel yourself annoyed here. 3. Not knowing where to find her, I have returned. 4. Frederick is punished. 5. Honour thy father and thy mother, and thou shalt be honoured. 6 This book shall be bound to-morrow. 7. Be virtuous, and you shall certainly be rewarded for it. 8. John has been punished for not having finished his exercise. 9. Speak loud, that you may be heard. 10. It is sad to be hated by all. 11. He feels pleasure in being praised. 12. We have gathered many strawberries.

VOCABULARY.

A che ora, at what o'clock.
Affliggersi, to grieve.
Anche, also, too.
A una (ora), *alle due*, *tre*, etc. (*ore*), at one, at two, three, etc., o'clock.
Capire, to comprehend, understand.
Carrozza, coach.
Chiamarsi, to be called, bear a name.
Coprirsi, to cover oneself.
Coricarsi, to lie down, go to bed.
Cronestatte, Cronstadt.
Divertirsi, to divert, amuse oneself.
Fidarsi, to trust to, rely on.

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* Active verbs conjugated by *avere* require their participles to agree in *number* and *gender* with the accusative case (object) which they govern, and which, along with the nominative case (subject), *precedes them*. When the nominative, or subject, follows the verb, the participle *remains unchanged*, and *in most cases it is not changed* when the accusative, or object, follows.

† In Italian, to address politely, *Ella* or *Lei* (literally, *she*) must be used.

‡ Those verbs which end in *-ciare*, *-giare*, and *-sciare* drop the vowel *i* in all tenses where it meets with *i* or *e*: for example, *mangerò* for *mangierò*.

§ When both *gli*, to him, and *le*, to her *or* (in addressing politely) to you, happen to meet with one of the pronouns *lo*, *la*, *li*, *le*, *ne*, they are for the sake of euphony changed into *glielo*, *gliela*, it to him, it to her, it to you; *glieli*, *gliele*, them to him, them to her, them to you; and *gliene*, some to him, some to her, some to you (*or* of it, of them, to him, to her, to you). The sense of the passage is the only guide in such cases.

Fortuna, fortune, prosperity.
Francesco, Francis.
Lavarsi, to wash (oneself).
Mantello, cloak, great-coat.
Mattina, morning.
Momento, moment, instant.
Morte, death.
Non ancora, not yet.
Più tardi di, later than
Promessa, promise
Proporsi (past part. *proposto*), to make up one's mind, propose to oneself, intend, resolve.
Riposarsi, to repose or rest oneself.
Servirsi, to make use of.
Settimana che viene, next week.
Sinceramente, sincerely, truly.
Stanchissimo, very tired.
Vantarsi, to boast, pretend to.
Vestirsi, to put on one's clothes, dress (oneself).

EXERCISE 37.

Translate into Italian :—

1. My uncle will arrive this evening; we shall amuse ourselves well. 2. Why do you grieve? 3. I grieve for the death of my cousin. 4. Rejoice, friends, in the little which you have. 5. Do not rely on him. 6. Remember your promise. 7. Wrap yourself with your cloak. 8. I shall make use of your books. 9. We often make use of this carriage. 10. I dress myself. 11. We shall dress ourselves by-and-by. 12. At what hour do you usually rise? 13. I rise every morning at six, and I go to bed at nine. 14. We rise later than you. 15. Rest yourself a little. 16. I will rest myself a moment; I am very tired. 17. What is this young man's name? 18. I believe his name is William. 19. These gentlemen are much amused at the ball. 20. They intend to go there next week also.

VOCABULARY.

Ancora, yet, still.
Andarsene,* to go away.
Canto, singing, song.
Cercare, to seek, search.
Da gran tempo, long [since
Desiderare, to desire, wish.
Disgrazia, misfortune, disaster.
Maritarsi, to marry, get married.
Nuova York, *Neoiorca*, New York.
Osteria, inn, tavern, public house.
Quasi, almost, as if.
Rivenire, to return.
Scusarsi, to excuse oneself.
Subito, immediately.
Udire, to hear.
Vogliono, they are willing.

EXERCISE 38.

Translate into Italian :—

1. They say that Mrs. Johnson will get married. 2. People know their friends in misfortunes. 3. One most always seeks a fortune where it is not. 4. They speak fifty-three languages in Europe. 5. It is no longer spoken of. 6. What must be done to prevent such a misfortune? 7. It is necessary always to labour; it is not necessary to be idle. 8. It will be needful to have patience. 9 It was necessary that I should write a letter. 10. I am going. 11. Are you going already? 12. It is necessary for me to go. 13. Your mother is not going yet. 14. Excuse me, my mother is already gone, and my brothers will go directly. 15. Wait a moment longer; we will go together.

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* The irregular tenses of *andare*, to go, required for this exercise are as follows :—

IND. *Present.*—Vò (vádo), vái, va ; andiámo, andáte, vánno.
SUB. *Present.*—Váda, váda, váda ; andiamo, andiáte, vádano.
Future.—Andrò.
IMPERATIVE. Va, váda ; andiámo, andáte, vádano.

IRREGULAR VERBS OF THE FIRST CONJUGATION.

The *Irregular Verbs* are those which deviate in some tenses and persons from the regular verb of the same conjugation which is given for their model.

The first irregular conjugation contains only *andáre*, *dáre*, *fáre*, *stáre*, and their derivatives.

As all Italian verbs may be generally conjugated with or without personal pronouns, we now think proper to omit them in the conjugation of the irregular verbs, feeling confident that the student is thoroughly acquainted with them. For a similar reason we omit the conjugation of the compound tenses, which the reader now will be easily able to form and conjugate for himself.

The irregular verb *andáre*, to go, is thus conjugated :—

INDFF. *Simple Tenses.—Pres.* Andáre, *to go.—Pres. Gerund.* Andándo, *going.—Past Part.* Andáto, andáta, andáti, andáte, *gone.*——*Compound Tenses.—Past.* Éssere andáto, *to have* or *be gone.—Past Gerund.* Esséndo andáto, *having* or *being gone.*

IND. *Pres.* Vádo *or* vo, vái, va ; andiámo, andáte, vánno.—*Imp.* Andáva, andávi, andáva ; andavámo, andaváte, andávano. —*Ind. Pret.* Andái, andasti, andò ; andámmo, andáste, andárono.—*Fut.* Andrò, andrái, andrà ; andrémo, andréte, andranno.—*Cond. Pres.* Andréi, andrésti, andrébbe ; andrémmo, andréste, andrébbero.

IMP. Va, váda ; andiámo, andáte, vádano.

SUB. *Pres.* Che váda, che váda *or* vádi, che váda ; che andiámo, che andiáte, che vádano. —*Imp.* Che andássi, che andássi, che andasse ; che andássimo, che andáste, che andássero.

After this example conjugate *riandáre*, to go again.

The irregular verb *dáre*, to give, is thus conjugated :—

INDEF. *Simple Tenses.—Pres.* Dáre, *to give.—Pres. Gerund* Dándo, *giving.—Past Part.* Dáto, *given.*——*Compound Tenses. —Past.* Avére dáto, *to have given.—Past Gerund.* Avéndo dáto, *having given.*

IND *Pres.* Do, dái, dà ; diámo, dáte, dánno.—*Imp.* Dáva; dávi, dáva ; davámo, daváte, dávano.—*Ind. Pret.* Diédi *or* détti, désti ; diéde, détte, *or* diè. Démmo ; déste ; diédero, déttero, diérono, *or* diédono.—*Fut.* Darò, darái, darà ; darémo, daréte, daránno. —*Cond. Pres.* Daréi, darésti, darébbe ; darémmo, daréste, darébbero.

IMP. Dà, día ; diámo, dáte, díano or dieno.

SUB. *Pres.* Che día ; che día *or* díi ; che día. Che diámo ; che diáte ; che díano, dieno, déano.—*Imp.* Che déssi, che déssi, che désse ; che déssimo, che déste, che déssero.

After this example conjugate *ridáre*, to give again ; *addáre* or *addársi*, to apply oneself.

The irregular verb *fáre*, to make, is thus conjugated :—

INDEF. *Simple Tenses.—Pres.* Fáre, *to make.—Pres. Gerund.* Facéndo, *making.* — *Past Part.* Fátto, *made.* —— *Compound Tenses.—Past.* Avére fátto, *to have made.—Past Gerund.* Avéndo fátto, *having made.*

IND. *Pres* Fo *or* fáccio, fái, fa ; facciámo, fáte, fánno.—*Imp.* Facéva, facéa, or fê ; facévi ; facéva *or* facéa. Facevámo ; faceváte ; facévano or facéano.—*Ind. Pret.* Féci or féi ; facésti ;

féce, fè, *or* féo. Facémmo; facéste; fécero *or* fénno.—*Fut.* Farò, farái, farà; farémo, faréte, faránno.—*Cond. Pres* Faréi, farésti, farébbe; farémmo, faréste, farébbero.

Imp. Fa, fáccia; facciámo, fáte, fácciano.

Sub. *Pres.* Che fáccia, che fáccia *or* fácci, che fáccia; che facciámo, che facciáte, che fácciano.—*Imp.* Che facéssi, che facéssi, che facésse; che facéssimo, che facéste, che facéssero.

After this example conjugate the following irregular verbs :—

Assuefáre, *to accustom.*
Confáre, *to become.*
Contraffáre, *to mimic.*
Disfáre, *to undo.*
Liquefáre, *to melt*
Misfáre, *to do wrong.*

Rifáre, *to make up again.*
Sfáre, *to undo.*
Sopraffáre, *to ask too much.*
Soddisfare, *to satisfy.*
Strafáre, *to do too much.*
Stupefare, *to stupefy.*

The irregular verb *stáre*, to stand (which is sometimes used instead of *essere*, as, *io sto a Roma* for *io sono a Roma*), is thus conjugated :—

Indef. *Simple Tenses.—Pres.* Stáre, *to stand.—Pres Gerund.* Stándo, *standing.—Past Part.* Státo, *stood.——Compound Tenses —Past.* Éssere státo, *to have stood.—Past Gerund.* Essendo státo, *having stood.*

Ind. *Pres.* Sto, stái, sta; stiámo, státe, stánno.—*Imp.* Stáva, stávi, stáva; stavámo, stavate, stávano.—*Ind. Pret.* Stétti, stésti, stétte; stémmo, stéste, stéttero.—*Fut.* Starò, starái, starà; staremo, staréte, staránno —*Cond Pres.* Staréi, starésti, starébbe; starémmo, staréste, starébbero.

Imp. Sta, stía *or* stíe; stiámo, státe, stiano *or* stíeno.

Sub. *Pres.* Che stía, che stía *or* stíi, che stía; che stiamo, che stiáte, che stíano *or* stíeno.—*Imp* Che stéssi, che stéssi, che stésse; che stéssimo, che stéste, che stéssero.

After this example conjugate the following irregular verbs :—

Distáre, *to be distant.*
Iustáre, *to insist.*

Ristáre, *to stop.*
Soprastáre, *to defer, delay*

MENSURATION.—IV.

[*Continued from p.* 229.]

AREAS OF IRREGULAR FIGURES AND FIGURES BOUNDED BY CURVED LINES.

Problem XII.—To find the area of a regular polygon, the length of the side being given.

Rule.—Find the radius of the inscribed circle by previous rule; then multiply the length of the side by the number of sides, and this by the radius, and half the product will give the area.

Example.—The length of the side of a regular pentagon is 3; what is its area?

Find the radius of the circumscribed circle, thus :—

The ∠ (angle) at the centre $= \frac{360^\circ}{5} = 72^\circ$; $\frac{72^\circ}{2} = 36^\circ = \angle$ A O C (Fig. 15, page 168).

Then half the side or $\frac{3}{2} = 1{\cdot}5 =$ base of right-angled triangle A O C, and hypothenuse A O $= \frac{\text{base}}{\text{nat. sine } \angle\, 36^\circ}$ or $\frac{1{\cdot}5}{{\cdot}5878} = 2{\cdot}55$.

Again, perpendicular O C = hypothenuse × nat. sine ∠ O A C, or $2{\cdot}55 \times {\cdot}3090 = 2{\cdot}06 =$ radius of inscribed circle.

Then $\frac{3 \times 5 \times 2{\cdot}06}{2} = 15{\cdot}45$, area of pentagon.

Exercise 16.

1. What is the area of a pentagon whose side is 3·82?

2. The side of a hexagon measures 20 poles; what is its area?

3. The side of an octagon measures 20 yards; what is its area?

4. The side of an equilateral triangle is 389 links; required its area.

5. The side of an octagon is 156 feet; what is its area?

Problem XIII.—To find the area of any irregular figure, the boundary sides of which are straight.

Rule.—Divide the figure into separate triangles. If the diagonals are given, find at once the area of the respective triangles, as explained in Problem XI., and their sum will be the area. If the diagonals are not given, they must be obtained by actual measurement.

Exercise 17.

1. The four sides of an irregular figure are as follow :—B A = 12; A C = 20; C D = 18; and D B = 10; and the diagonal from A to D measures 6. What is the area of the figure?

2. The four sides being as above, but the diagonal being 12, what is the area?

3. A figure has five sides, as follow :—A B = 22; B C = 18; C D = 32; D E = 18; and E A = 20; and the diagonals E B and B D measure respectively 23·25 and 16·75. What is the area of the figure?

We shall now consider the superficial area of surfaces bounded by curved lines; and we request our reader to refresh his memory by a reference to our remarks upon the proportion which exists between the diameter and the circumference of a circle?

Problem XIV.—The radius of a circle being given, to find its area.

$$\text{Area} = \pi r^2.$$

$$\therefore \text{area} = \frac{2\pi r \times r}{2}.$$ Hence the rule as follows :—

Rule 1.—Multiply the radius by the circumference, and halve the product.

Note.—The circumference of a circle being to its diameter in the proportion of 3·1416 (approximately) to 1, it follows that its proportion to the radius is as 3·1416 (a number we shall designate generally by π) to ½, and hence the truth of the above rule.

Example 1.—Required the area of a circle whose diameter (D) is 1.

Here $R = \frac{D}{2}$ or $\frac{1}{2}$; and the area is $\frac{1}{2} \times \frac{\pi}{2}$ or $\frac{3·1416}{4} = ·7854$. This number may be with great advantage borne in mind by the student, it being the area of a circle whose diameter is unity. It is often used in estimating circular areas.

Example 2.—The radius of a circle is 1. What is its area?

In this case, R being 1, D is 2, and the circumference becomes 2π or 6 2832.

Therefore the area is $R \times \frac{6·2832}{2} = 3·1416$.

Exercise 18.

1. The diameter of a circle is 3; what is its area?
2. The circumference of a circle is 3·1416; what is its area?
3. The diameter of a circle is 4 feet 11 inches; what is its area?
4. The area of a circle is 18 feet 142 inches (square measure); what is its radius?
5. A circular plot of ground contains one acre; what is its diameter?

We call the attention of the reader to Examples 1 and 2 under Problem XIV. It will be there observed that when the diameter is 1 the area is ·7854, and when it is 2 the area is 3·1416—that is to say, *double* the diameter produces *four* times the area. This we might expect. But by further comparison it will be seen that in either case the area is equivalent to the square of the diameter multiplied by the same figures, ·7854. Hence we obtain

Rule 2.—The area of a circle is equal to $D^2 \times ·7854$.

Example 1.—The radius of a circle is 1; what is its area? (*See* Example 2 under last rule.)

$R = 1$, $\therefore D = 2$. And $D^2 \times ·7854 = 4 \times ·7854 = 3·1416$, which corresponds with the answer obtained by Rule 1.

Exercise 19.

1. A circular table is 59 inches in diameter; what is its area by Rule 2?
2. Find the area of a circle whose diameter is 78¼ yards.

Problem XV.—The circumference only of a circle being given, to find its area.

$$\text{Radius} = \frac{\text{circumference}}{2\pi},$$
$$\text{then area} = \pi r^2.$$

Hence the *Rule:* Divide the circumference by 2π, square the result, and multiply by π.

Example.—The circumference of a circle is 3·1416; what is its area?

$$r = \frac{3·1416}{2\pi} = \tfrac{1}{2},$$
$$\therefore \pi r^2 = \frac{3·1416}{4} = ·7854.$$

Exercise 20.

1. The circumference being 6, what is the area of the circle?*
2. The circumference of a circular plot of ground is 246 yards 1 foot 10¼ inches; what is its area?
3. How many square yards are contained in a circular table whose circumference is 11 feet?

Problem XVI.—To find the area of the sector of a circle.

Rule 1.—Multiply the radius by half the length of the arc of the sector.

Rule 2.—As 360 degrees is to the number of degrees in the given arc, so is the whole area of the circle to the area of the sector.

Example 1.—The radius of a circle is 6, and the length of the arc is 12; what is the area of the sector?

By Rule 1. $R \times \frac{\text{length of arc}}{2} = 6 \times 6 = 36$.

By Rule 2. 360° : 114·6° : : 113·1 (whole area of circle) : 36.

Note.—A sector may assume the form of Fig. 22, as well as of Fig. 21.

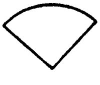
Fig. 21.

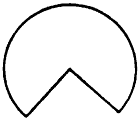
Fig. 22.

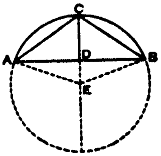

Fig. 23.

Exercise 21.

1. Find by both rules the area of a sector, the length of the radius being 5 feet, and the length of the arc 20 feet.
2. The arc of a circle contains 36° 42′ 16″, and the length of the radius is 4; required the area of the sector.
3. The diameter of a circle is 578 feet, and the number of degrees in the arc is 93° 48′ 30″; what is the area of the sector in acres, roods, etc.?

Problem XVII.—To find the area of a segment of a circle.

Rule 1.—When the number of degrees in the segment is given. Find the area of the sector ACBE (Fig. 23), and then the area of the triangle ABE. If the segment is less than a semicircle, the difference of these will be the area of the segment; if it be greater, the area is the sum.

---

* The fact that the area appears less than the circumference is because the latter is square measure and the former lineal.

Rule 2.—From the arc of the segment subtract its sine, and multiply the remainder by half the radius.

Rule 3.—Area $\frac{4}{3}\,h \times \sqrt{\frac{1}{4}c^2 \times \frac{4}{10}h^2}$, in which h is the height of the segment, or its versed sine, and c is the chord.

Note.—This rule is approximate only.

Example 1.—What is the area of the segment of a circle, the number of degrees being 27 and the length of the radius 20?

By Rule 1. To find the area of the sector ACBE (Fig. 26). As 360° : 27° : : 1256·6 (whole area of circle) : 94·24, area of sector.

Again: To find the area of the triangle ABE (Fig. 26).

Because ∠ AEB = 27°, ∴ ∠ AED = 13·5°, and ∠ ADE is a right angle. Hence DE = AE × nat. sine ∠ DAE.

But ∠ DAE = 90° − 13·5° = 76·5°;

∴ DE = 20 × ·9724 = 19·448.

Then in the right-angled triangle ADE,

$\text{AD} = \sqrt{\text{AE}^2 - \text{DE}^2} = \sqrt{400 - 378{\cdot}22} = 4{\cdot}66.$

We have now a triangle in which the base AB and the altitude DE are known; hence its area $= \text{AB} \times \frac{\text{DE}}{2}$ or $9{\cdot}32\ (4{\cdot}66 \times 2) \times \frac{19{\cdot}448}{2} = 90{\cdot}6.$

Finally, area of segment ACBD = 94·24 (area of sector) — 90·6 (area of triangle) = 3·64. *Ans.*

Solve the same question by Rule 3.

$$\text{Area} = \frac{4}{3}\,{\cdot}552\,(\text{CE}-\text{DE}) \times \sqrt{\frac{9{\cdot}32^2}{4} + \frac{4 \times {\cdot}552^2}{10}}.$$

$$= {\cdot}736 \times \sqrt{21{\cdot}7 \times {\cdot}122} = {\cdot}736 \times 4{\cdot}78 = 3{\cdot}518.\ \textit{Ans.}$$

It will be seen, by comparing the two answers solved differently, that they do not agree. A closer approximation would result by carrying the decimal places farther, but the first answer is the more correct.

Exercise 22.

1. Required the area of the segment of a circle, the number of degrees in the arc being 107° 30′, and the length of the radius 12·41.

2. What is the area of a segment, the length of arc being 46·58, and the whole circumference being 156?

Problem XVIII.—To find the area of a circular zone, ABCDEF (Fig. 24).

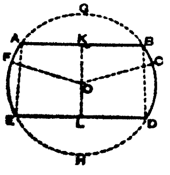

Fig. 24.

Draw the straight lines AE, BD; the zone is then divided into a trapezoid, ABDE, and two segments, AFE, BCD.

Rule 1.—Find the area of the trapezoid by rule to Problem XI., and also the area of the two segments, AFE, BCD. The sum of these areas will be the area of the zone.

Rule 2.—Find the area of the two segments AGB, EHD, which subtract from the area of the whole circle.

Example 1.—The radius of a circle is 5. A zone of that circle has one of its parallel chords passing through the centre of the circle, and the other chord equals the radius. What is the area of the zone?

By Rule 2. Area of whole circle $= d^2 \times \frac{\pi}{4} =$ 100 × ·7854 = 78·54.

Area of greater segment $= \frac{78{\cdot}54}{2}$ (semicircle) = 39·27.

To find area of smaller segment.

The chord of the arc of this segment being = radius, it forms the base of an equilateral triangle, each ∠ being $= \frac{180^\circ}{3} = 60^\circ$. Hence number of degrees in arc of segment = 60°.

Then by Tables. Segment of 60° = ·0906, and area = ·0906 × r^2 (or 25) = 2·265. Then area of zone = 78·54 (area of whole circle) less areas of segments (39·27 + 2·265), or 41·535 = 37·005. *Ans.*

Exercise 23.

1. The parallel chords of a circular zone are 5 and 6, and the diameter of the circle is 20; what is the area of the zone?

2. The radius of a circle is 14, and the lengths of the parallel chords of a zone of that circle are 22 and 28. Required the area of the zone.

Problem XIX.—To find the area of a circular ring, ABCD, A′B′C′D′ (Fig. 25), that is, of the space included between two concentric circles.

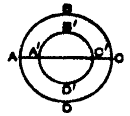

Fig. 25.

Rule.—Find the area of the interior circle, which subtract from the area of the outer circle.

This simple problem and its rule are so self-evident as scarcely to need an example. We refer our readers to Problem XIV. for all the information requisite. We give one example for practice.

Example.—The diameter of the earth's orbit being (approximately) 180000000 miles, and that of the earth being 7912 miles, what part of the superficial area of the orbit is occupied by a plane passing through the diameter of the earth and bounded by its circumference? *Ans.* 517574000.

Problem XX.—To find the area of a lune, as ABCD (Fig. 26).

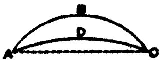

Fig. 26.

Rule.—Find the area of the two segments, and their difference will be the area of the lune.

Example.—What is the area of a lune, the chord A C of which is 48, and the height or versed sine of the two arcs 10 and 7 respectively? *Ans.*, about 103.

Problem XXI.—To find the superficial area of a sphere.

Rule 1.—Multiply the circumference of the sphere by its diameter.*

Rule 2.—Multiply the square of the diameter by 3·1416.

Example.—The diameter of the earth being 7912 miles, what is its superficial area, supposing it a perfect sphere?

By Rule 2, $d^2\pi = 62599744 \times 3{\cdot}1416 =$ about 196663356 miles.

Exercise 24.

1. What is the superficial area of a sphere whose radius is 1·5?

Problem XXII.—To find the surface of a regular solid ring.

Rule.—Find the length of the ring by adding together the exterior and interior diameters, and by multiplying half their sum by π. This product, multiplied by the circumference of the cross section of the ring, will give its superficies.

The formula is $\frac{D + d}{2} \times \pi \times c =$ area, in which $D =$ exterior diameter, $d =$ interior diameter, and $c =$ circumference of cross section of ring.

Example.—The inner and outer diameters of a ring are 8 and 12; what is its superficial area? *Ans.*, about 197·4.

Problem XXIII.—To find the area of an ellipse or oval.

Rule.—Multiply the product of the axes by $\frac{\pi}{4}$.

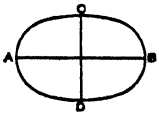

Fig. 27.

Note.—An ellipse is a figure formed by a plane cutting a cone in a direction parallel to neither side of the cone, nor yet to its base. It has two axes, the long and the short, as A B, C D (Fig. 27).

Example 1.—The major axis of an ellipse is 10, and the minor axis 7; what is its area?

$$10 \times 7 \times \frac{\pi}{4} = 70 \times {\cdot}7854 = \text{about } 54{\cdot}98.$$

Exercise 25.

1. What is the area of an ellipse whose axes are respectively 12 and 9?

SIMPSON'S RULE.

By this important rule we are enabled to calculate approximately the areas of figures bounded by irregular curves.

Let a O U g be a figure (Fig. 28) bounded by a straight line O U, and by two others, O a and U g, perpendicular to O U, and by the curve $a\,g$. Divide O U into an *even* number of equal parts at the points P, Q, R, etc., and from these points draw P b, Q c, etc., perpendicular to O U, meeting the curve in b, c, d, etc. Then find the area by the following rule.

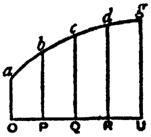

Fig. 28.

Rule.—Add together the first and last perpendiculars, twice the sum of all the other odd perpendiculars, and four times the sum of all the even perpendiculars. Multiply this sum by one-third of the common perpendicular distance between the perpendiculars; this gives the area.

Example.—Suppose there are 5 ordinates, the distance between each pair being 4 feet, and the ordinates measuring 5, 5·3, 6·1, 7, and 7·6 feet, respectively.

$$\text{Area} = \left\{5 + 7{\cdot}6 + 2(6{\cdot}1) + 4\,(5{\cdot}3 + 7)\right\} \times \tfrac{4}{3}$$
$$= 98\tfrac{2}{3} \text{ square feet.}$$

N.B.—The greater the number of perpendiculars, the more correct will the answer be.

SOLIDS.

As a general definition, a solid may be regarded as a body having length, breadth, and thickness, and in this sense it of course includes *liquids*. It is, in fact, anything which is bounded by surfaces in all directions. The measurement of a solid is called its *cubical content*, and it involves two separate acts of multiplication. If the figure be a *cube*, its content is measured by the cube of one of the lines which connect any two adjacent angles. Thus, in Fig. 29 the contents will be represented by A B³, or A C³, or C D³. Suppose, however, that the length of A B = 1, then 1³ = 1; that is, the solid content of a cube whose side is unity is also unity, the difference being between lineal and solid measure.

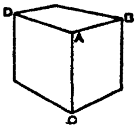

Fig. 29.

Example.—The solid content of a cube is required whose side measures 10.

10 × 10 × 10 (or 10³) = 1000, the solid measure.

Exercise 26.

1. What is the solid content of a cube whose side measures 2 feet 6 inches?

In order to find the length of the side of a cube whose solid content is known, extract the cube root of the contents.

In order to find the solid content of any other form of parallelopipedon than a cube, multiply the length by the breadth, and that product by the height.

---

* The superficial area of a sphere is equal to four times the area of a plane passing through its diameter.

Example 1.—Required the content of a parallelopipedon whose length, breadth, and height are respectively 12, 6, and 3.

$12 \times 6 = 72$; $72 \times 3 = 216$. *Ans.*

Example 2.—What is the content of a parallelopipedon whose length is 3 feet 2 inches, its breadth 2 feet 3 inches, and its height 1 foot 4 inches? *Ans.*, 9 cubic feet 864 cubic inches.

The solid content of a prism or cylinder is found by multiplying the area of the end by the length.

Example 1.—A hollow cylinder is 12 inches in diameter inside and 12 inches high; how many cubic inches of water will it contain?

$12^2 \times {\cdot}7854 = 113{\cdot}1$, nearly = area of base.

$113{\cdot}1 \times 12 = 1357{\cdot}2$ cubic inches.

Exercise 27.

1. Required the solid content of a triangular prism whose height is 3 feet, and the breadth of each side 6 inches.

The solidity of a cone is determined by multiplying the area of the base by one-third the height.

The cubic content of a sphere or globe is ascertained by multiplying the cube of the diameter by $\cdot 5236$; this number being $\frac{\pi}{6}$.

Example 1.—What is the content of a globe whose diameter is 10?

$10^3 = 1000$; $1000 \times {\cdot}5236 = 523{\cdot}6$.

Exercise 28.

1. The mean diameter of the earth being 7912 miles, what is its cubic content, supposing it a regular sphere?

To find the solid content of a segment of a sphere, add the square of its height to three times the square of the radius of the base. Multiply the sum by the height, and that product by $\frac{\pi}{6}$.

Example.

What is the content of the segment of a sphere whose height is 2, and the diameter of the base 8?

By rule, $2^2 + (3 \times 4^2) = 52$;

$$52 \times 2 \times {\cdot}5236 \left(\frac{\pi}{6}\right) = 54{\cdot}4544. \quad \textit{Ans.}$$

To find the solid content of a zone of a sphere, add the square of the height to three times the sum of the squares of the radii of the two ends; multiply the result by the height, and then by $\frac{\pi}{6}$ or $\cdot 5236$.

The solid content of a regular solid ring is found by multiplying the area of the cross section of the ring by its length, the length being found by multiplying the mean diameter (that is, half the sum of the inner and outer diameters) by π.

We need scarcely observe that there are many more problems in connection with the measurement of the content of solid bodies—as, for instance, of a circular spindle; of a spheroid, or the segment of a spheroid; of a paraboloid, or the frustum of a paraboloid; of a hyperboloid, or its segment; and so on. But our subject is directed principally to a consideration of the areas of *flat* surfaces, so as to apply the rules to the measurement of land. We have merely and briefly called the student's attention to the more common forms of regular solids, and shall in our next lesson commence the subject of Land Surveying.

KEY TO EXERCISES.

Exercise 8.

1. 19·045.
2. 7920 miles and 8 inches.

Exercise 9.

1. About 35·35 feet.
2. About 48·99 feet
3. 58 feet.

Exercise 10.

1. About 69·16 miles.
2. 60°.

Exercise 11.

1. 49 feet 9 inches.
2. 96.

Exercise 12.

1. 100.
2. 1296
3. 121.
4. Nearly 316·2 links and 69·6 yards.
5. 65600 square yards.
6. £3520.
7. 60°.
8. 150 feet.

Exercise 13.

1. About 14·13.
2. 3 roods, 8 poles.
3. 5 chains.

Exercise 14.

1. 451·5.
2. About 1 acre, 3 roods, 17½ poles.
3. 1526·4.
4. Nearly 15·6.
5. 1 acre, 1 rood, 10 poles.

Exercise 15.

1. Nearly 178.
2. 311008.
3. 57 square feet.

Exercise 16.

1. 25 116.
2. 1039·2 square poles.
3. 1931·2 square yards.
4. 65522 square links.
5. 84800 square feet.

Exercise 17.

1. Triangle ADB = 29·93. Triangle ADC = 53·66. Total area = 83·59

N.B.—Find the area of each triangle from the three sides as shown in Problem XI.

2. Triangle ADB = 42·25. Triangle ADC = 106·7. Total area = 148·95.
3. Triangle ABE = 191·45. Triangle BDE = 149·90. Triangle BDC = 108·31. Total area = 449·66.

Exercise 18.

1. 7·0686.
2. ·7854
3. 2735 square inches.
4. 2 ft. 5½ inches nearly.
5. 78·48 yards.

Exercise 19.

1. 2733·9774 square inches.
2. 4828·7 square yards.

Exercise 20.

1. 2·86.
2. 134 yds., 10 ft., 970 inches.
3. 1·07 square yards.

EXERCISE 21.

1. 80 square feet.
2. 5·13 nearly.
3. 1 acre, 2 roods, 21 poles, 4½ yards.

EXERCISE 22.

1. Area of sector = 144·48.
   Area of triangle = 73·44.
   Area of segment = 71·04.
2. Area of sector = 578·37.
   Area of triangle = 293·9.
   Area of segment = 284·47.

EXERCISE 23.

1. Area of 2 sectors = 2·98.
   Area of circle = 314 16.
   Area of zone = 311·23.
2. Area of semicircle = 307·88.
   Area of segment = 81·31.
   Area of zone = 226·57.

EXERCISE 24.

1. 28·2857.

EXERCISE 25.

1. 84·857.

EXERCISE 26.

1. 15·625 square feet.

EXERCISE 27.

1. 458·136 cubic inches.

EXERCISE 28.

1. 259333411782 cubic miles.

LATIN.—XLI.

[Continued from p 232]

LATIN READINGS (*continued*).

JUVENAL.

HERE is Juvenal's complaint against the inroad into the city of all sorts of Greek adventurers, conjurors, dancers, and mountebanks, who came from their own impoverished country to enrich themselves by the extravagance of the Romans :—

JUVENAL.—"SAT.," III. 58—85.

Quae nunc divitibus gens acceptissima nostris
Et quos praecipue fugiam, properabo fateri,
Nec pudor obstabit. Non possum ferre, Quirites,
Graecam urbem. Quamvis quota portio faecis
  Achaei ?
Jam pridem Syrus in Tiberim defluxit Orontes,
Et linguam et mores, et cum tibicine chordas
Obliquas, nec non gentilia tympana, secum
Vexit, et ad Circum jussas prostare puellas.
Ite, quibus grata est picta lupa barbara mitra.
Rusticus ille tuus sumit trechedipna, Quirine,
Et ceromatico fert niceteria collo.
Hic alta Sicyone, ast hic Amydone relicta,
Hic Andro, ille Samo, hic Trallibus aut Alabandis,
Esquilias dictumque petunt a vimine collem,
Viscera magnarum domuum, dominique futuri.
Ingenium velox, audacia perdita, sermo
Promtus, et Isaeo torrentior. Ede quid illum
Esse putes : quem vis hominem, secum adtulit ad
  nos :
Grammaticus, rhetor, geometres, pictor, aliptes,
Augur, schoenobates, medicus, magus : omnia novit
Graeculus esuriens : in coelum jusseris, ibit.
Ad summam, non Maurus erat neque Sarmata nec
  Thrax,
Qui sumsit pennas, mediis sed natus Athenis.
Horum ego non fugiam conchylia ? Me prior ille
Signabit ? fultusque toro meliore recumbet
Advectus Romam, quo pruna et cottana vento ?
Usque adeo nihil est, quod nostra infantia coelum
Hausit Aventinum, bacca nutrita Sabina ?

NOTES.

Quirites. The oldest and most honourable title of the Roman people, and adopted in all formal proclamations. By thus using it, Juvenal seems to wish to appeal to their national pride.

Graecam, "a Græcised capital."

Quamvis. "Though after all what a small portion is it of the dregs of Greece !"

Mitra. The high Phrygian cap was a peculiarity of the Greeks of Asia Minor.

Trechedipna. A word coined from the Greek (τρέχω δεῖπνον), "the slippers which carry him off at a run to the feast."

Niceteria. Another Greek word, νικητηρια, "prizes of victory."

Sicyone, etc All names of places in Greece.

Dictum a vimine The *mons Viminalis.*

Ingenium, sc. *est illis.* "They have talent and impudence." etc

Schoenobates. A Greek word signifying a "rope-dancer."

Graeculus, etc. "The hungry Greekling knows everything; bid him start for heaven, he'll be off."

Conchylia, "purple robes" The word originally means a "shell-fish," from which the purple dye was obtained, and so came to be used for the dye itself, and for purple robes.

Signabit "Shall such a man take precedence of me in business matters?"

Advectus Romam, etc , "who was borne to Rome by the same wind that brings the plums and figs'—*i.e.*, from the East. *Cottana* were a small species of fig, found in Syria.

Usque adeo, etc. "Is it to come just to nothing at all that," etc.

CATULLUS.

The writings of Catullus rank among the best specimens of Roman poetry, not only from their thought, but also (and chiefly) from the elegance of their diction and the scrupulous accuracy of their rhythm. Indeed, Niebuhr, the great German historian—to whose criticisms on the literature of Rome we have already on more than one occasion alluded—goes so far as to place him at the head of the Roman poets. He remarks of him that "He does not anxiously seek for forms and words : poetry is with him the same natural expression, the same natural language, as our own common mode of expressing our thoughts is with us; he was a gigantic and extraordinary genius." Such terms of praise may seem somewhat exaggerated, though no one can deny the claim of Catullus to be considered a true poet. Unfortunately, we possess but few of his writings—no more indeed than 116 pieces—of which but some two or three run to any length, many of them being only from four to twelve lines each. They are of various kinds, but chiefly lyrical and epigrammatical; and their metres are close and accurate copies of the Greek measures, and the form is almost completely Greek. Here is a charming little poem on the death of his mistress's pet sparrow:—

CATULLUS, III.—"LUCTUS IN MORTE PASSERIS."

Lugete, O Veneres Cupidinesque,
Et quantum est hominum venustiorum:
Passer mortuus est meae puellae.
Passer, deliciae meae puellae,
Quem plus illa oculis suis amabat.
Nam mellitus erat, suamque norat
Ipsam tam bene quam puella matrem:
Nec sese a gremio illius movebat,
Sed circumsiliens modo huc modo illuc,
Ad solam dominam usque pipilabat.
Qui nunc it per iter tenebricosum
Illuc, unde negant redire quemquam.
At vobis male sit, malae tenebrae
Orci, quae omnia bella devoratis:
Tam bellum mihi passerem abstulistis.
O factum male! O miselle passer!
Tua nunc opera meae puellae
Flendo turgiduli rubent ocelli.

NOTES.

Veneres Cupidinesque The plural appears to be used merely for poetical effect.

Quantum—hominum, equivalent to *omnes homines*, "whatever of mankind," for "all mankind."

Deliciae. Plural in apposition with *passer*, sing., as only being found in plural. So *litterae*, "a letter," etc.

Ipsam, "her mistress" To the sparrow Lesbia was *ipsa*—the one person in all the world. In the same way, *ipse* in Latin and *αὐτός* in Greek were used by the disciples of a philosopher's school to denote the master. Hence the phrase *ipse dixit* (the master said it) to denote an authoritative statement.

Qui nunc it. By a poetical conceit the sparrow is supposed to go, like human beings, to the shades below after death.

Unde negant. So Hamlet speaks of "That undiscovered country from whose bourne no traveller returns."

Male sit, "curses on you."

Tua nunc opera, etc. "On your account the pretty eyes of my love are swollen and red with tears." *Ocellus* is here used as an affectionate diminutive of *oculus*.

The next extract is the poet's welcome to his home:—

CATULLUS, XXXI.—"AD SIRMIONEM PAENINSULAM."

Paeninsularum, Sirmio, insularumque
Ocelle, quascunque in liquentibus stagnis
Marique vasto fert uterque Neptunus:
Quam te libenter, quamque laetus inviso,
Vix mi ipse credens Thyniam atque Bithynos
Liquisse campos, et videre te in tuto.
O quid solutis est beatius curis?
Quum mens onus reponit, ac peregrino
Labore fessi venimus Larem ad nostrum,
Desideratoque acquiescimus lecto.
Hoc est, quod unum est pro laboribus tantis.
Salve, O venusta Sirmio, atque hero gaude:
Gaudete vosque, Lydiae lacus undae:
Ridete quidquid est domi cachinnorum.

NOTES.

Sirmio, a peninsula on Lake Benacus, now *Lago di Garda*.

Ocelle, "the gem." See note on line 17 of last extract.

Uterque Neptunus. The god of either kind of water—*stagna* (inland) or *maria* (open sea).

Solutis—curis, "than freedom from care."

Hoc est, etc. "This one thing is in itself sufficient recompense for all our toils."

Hero gaude, "rejoice at, welcome, your master."

Lydiae lacus. Benacus is so called because the Rhæti, who lived in the neighbourhood, were said to be of Lydian origin.

Quidquid est, etc. "Laugh, everything at home that can laugh" Compare line 2 of the last piece.

Here is an epigram on one Arrius, whose pronunciation was at fault:—

CATULLUS, LXXXIV.—"DE ARRIO."

Chommoda dicebat, si quando commoda vellet
Dicere, et hinsidias Arrius insidias:
Et tum mirifice sperabat se esse locutum,
Quum, quantum poterat, dixerat hinsidias.
Credo sic mater, sic Liber avunculus ejus,
Sic maternus avus dixerat, atque avia.
Hoc misso in Syriam, requierant omnibus aures:
Audibant eadem haec leniter et leviter,
Nec sibi postilla metuebant talia verba,
Quum subito adfertur nuntius horribilis,
Ionios fluctus, postquam illuc Arrius isset,
Jam non Ionios esse, sed Hionios.

NOTES.

Chommoda, etc. This was Arrius' pronunciation of *commoda* The point may be preserved in the translation; thus, "Arrius used to say hadvantages when he meant advantages, and hambushes for ambushes."

Et tum, etc. He thought he had caught the pronunciation perfectly when he sounded the *h* as strongly as possible.

Credo, etc. "I suppose it had run in the family."

Hoc misso. "When Arrius was sent off to Syria, we hoped that we had got rid of his barbarous solecisms; but no—news came that as soon as he got to the Ionian sea, it was Ionian no longer, but Hionian."

The following lines are from the Epithalamium or Nuptial Song of Peleus and Thetis, the longest of the poet's writings :—

CATULLUS, LXIV.—"EPITHALAMIUM PELEI ET THETIDOS," 335—382.

Nulla domus tales umquam contexit amores :
Nullus amor tali conjunxit foedere amantes,
Qualis adest Thetidi, qualis concordia Peleo.
Currite ducentes subtemina, currite, fusi.
Nascetur vobis expers terroris Achilles,
Hostibus haud tergo, sed forti pectore notus :
Qui persaepe vago victor certamine cursus
Flammea praevertet celeris vestigia cervae.
Currite ducentes subtemina, currite, fusi.
Non illi quisquam bello se conferet heros,
Quum Phrygii Teucro manabunt sanguine campi,
Troicaque obsidens longinquo moenia bello
Perjuri Pelopis vastabit tertius heres.
Currite ducentes subtemina, currite, fusi.
Illius egregias virtutes claraque facta
Saepe fatebuntur gnatorum in funere matres,
Quum in cinerem canos solvent a vertice crines,
Putridaque infirmis variabunt pectora palmis.
Currite ducentes subtemina, currite, fusi.
Namque velut densas prosternens messor aristas,
Sole sub ardenti flaventia demetit arva,
Trojugenûm infesto prosternet corpora ferro.
Currite ducentes subtemina, currite, fusi.
Testis erit magnis virtutibus unda Scamandri,
Quae passim rapido diffunditur Hellesponto :
Cujus iter caesis angustans corporum acervis,
Alta tepefaciet permista flumina caede.
Currite ducentes subtemina, currite, fusi.

* * * * * * * *

Quare agite, optatos animi conjungite amores.
Accipiat conjux felici foedere divam,
Dedatur cupido jamdudum nupta marito.
Currite ducentes subtemina, currite, fusi.
Non illam nutrix orienti luce revisens,
Hesterno collum poterit circumdare filo.
Currite ducentes subtemina, currite, fusi.
Anxia nec mater discordis moesta puellae
Secubitu, caros mittet sperare nepotes.
Currite ducentes subtemina, currite, fusi.

NOTES.

Qualis adest, etc. *concordia—Thetidi.* "As the harmony that reigns between Peleus and Thetis."

Currite. After each set of four lines comes a sort of incantation by way of refrain—"Roll on, ye spindles of destiny, unwinding their threads of life." So in Gray's "Bard"—"Weave the warp and wind the woof."

Expers terroris, "free from fear, dauntless."

Victor certamine. His epithet in Homer is πόδας ὠκύς, "the swift-footed."

Flammea, "fiery, glowing," and so "swift." *Praevertet*, "shall outstrip."

Tertius heres. Agamemnon, third in descent from Pelops, his father being Atreus, the son of Pelops.

In cinerem. "Shall shake their hoary locks from their heads into the ashes." Putting ashes on the hair was in the East looked upon as a token of grief.

Putrida, "pallid, livid."

Scamandri was one of the rivers of the plains of Troy, and it is frequently mentioned in Homer along with *Simois*, another Trojan river. Both of these are now small streams, generally half dried up.

Hellesponto. The Scamandri fall into the Ionian Sea just at the mouth of the Hellespont.

Angustans, sc. Achilles, who is the subject of *tepefaciet* in the next line.

Permista—caede, *i.e.*, polluting it with the hot blood of the warriors he had slain.

PLAUTUS.

Latin comedies are among the earliest specimens of Roman literature that have come down to our time ; and of the many authors who have distinguished themselves by their productions in this branch of literature, Plautus and Terence are the only two with whose works we are at all intimately acquainted. The forms of their works are based upon Greek originals, as is the case with nearly all Roman poetry, the scenery being laid in Greece, and the very names of the characters being Greek also. Indeed, many of these plays are acknowledged adaptations of existing Greek comedies, while, strangely enough, the sentiments expressed are those of inhabitants of Rome. But although, as we have said, these comedies date from an early period in the history of Roman literature, the dramatic art was not of remarkably early growth in Rome. Four centuries had elapsed from the building of the city before dramatic exhibitions were introduced there for the first time, and the comedies of Plautus bear a date not very long posterior to that period. Plays were first introduced into Rome from Etruria, which was in all probability colonised from Greece at a very early period, and thus the dramatic art itself may be said to have come to Rome indirectly from Greece. Considering the early dates of the comedies of Plautus, they are in every respect very remarkable productions; the plots are carefully and intelligently elaborated; the language, though archaic in form and construction, is plain and intelligible, and the humour is genuine and seldom offensive. Indeed, one can hardly understand how Horace, a man of refined taste, and evidently very capable of appreciating humour, could pass upon the writings of Plautus the severe criticism in his "Ars Poetica," lines 270-272—

> "At vestri proavi Plautinos et numeros et
> Laudavere sales; nimium patienter utrumque,
> Ne dicam stulte, mirati."

(But your ancestors praised the poetry and wit of Plautus, according him in both respects a lenient, not to say stupid admiration.)

M. Accius Plautus, or T. Maccius Plautus—for there is some dispute about the correct form of his name—was born B.C. 254, and died B.C. 184. He lived, accordingly, about the period of the Second Punic War.

Our specimen of Plautus is taken from his comedy of the "Trinummus," or Three Pieces of Money, adapted, as the author says in the prologue, from a Greek original—"Philemo scripsit, Plautus vortit barbare" (Written by Philemo, turned by Plautus into the vernacular). The plot turns upon a sum of money which had been entrusted to one Callicles by Charmides for the benefit of his son during his absence in foreign lands. In the eyes of his friend Megaronides, he appears to have betrayed his trust, and he accordingly calls upon him to explain his conduct. He is able to do so satisfactorily, and Megaronides reproaches himself for his ill-grounded suspicions.

TRINUMMUS, ACT I, SC. 2, l. 150—185.

MEGARONIDES—CALLICLES.

ME. Pausa. Vicisti castigatorem tuum;
Occlusti linguam; nihil est, qui respondeam.
CA. Nunc ego te quaeso, ut me opera et consilio juves,
Communicesque hanc mecum meam provinciam.
ME. Polliceor operam. CA. Ergo ubi eris paullo post? ME. Domi
CA. Numquid vis? ME. Cures tuam fidem. CA. Fit sedulo
ME. Sed quid ais? CA. Quid vis? ME. Ubi nunc adulescens habet?
CA. Posticulum hoc recepit, quom aedis vendidit.
ME. Istuc volebam scire, i sane nunc jam.
Sed quid ais? CA. Quid? ME. Nunc virgo nempe apud te est. CA. Ita est;
Juxtaque eam curo cum mea. ME. Recte facis.
CA. Num quid, priusquam abeo, me rogaturu's? ME. Vale.
Nihil est profecto stultius, neque stolidius,
Neque mendaciloquius, neque argutum magis,
Neque confidentiloquius, neque periurius,
Quam urbani assidui cives, quos scurras vocant.
Atque egomet me adeo cum illis una ibidem traho,
Qui illorum verbis falsis acceptor fui:
Qui omnia se simulant scire, nec quidquam sciunt.
Quod quisque in animo habet aut habiturust, sciunt.
Sciunt id quod in aurem rex reginae dixerit;
Sciunt, quod Juno fabulata est cum Jove;
Quae neque futura neque facta, illi sciunt tamen.
Falson' an vero laudent, culpent, quem velint,
Non flocci faciunt; dum illud, quod lubeat, sciant.
Omnes mortales nunc hunc aibant Calliclem
Indignum civitate ac sese vivere,
Bonis qui hunc adulescentem evortisset suis.
Ego de eorum verbis famigeratorum inscius
Prosilui amicum castigatum innoxium.
Quod si exquiratur usque ab stirpe auctoritas,
Unde quidque auditum dicant, nisi id appareat,
Famigeratori res sit cum damno et malo.
Hoc ita si fiat, publico fiat bono.
Pauci sint faxim, qui sciant, quod nesciunt,
Occlusioremque habeant stultiloquentiam.

NOTES.

Pausa appears to be the imperative of an old verb, *pausare*, to cease; from the Greek *παύειν*. In some old writers the word *pausa* is found as a substantive, equivalent to *quies*. *Castigatorem*, "your accuser"; meaning himself.

Occlusti—contracted for *occlusisti*.

Communicesque, etc., "and undertake to share this charge of mine with me"; viz., the guardianship of the treasure on behalf of the son of Charmides. *Provinciam*, perhaps from *providentia* (*pro-video*), means "anything for the welfare of which you have to provide."

Ergo is used here without the illative force (therefore) which it usually bears, and simply serves as a link in the conversation, "Well, where will you be in a short time from this?" *Post* for *post hac*.

Numquid vis? An ordinary formula of leave-taking among the Romans, meaning literally, "Do you wish anything of me?" "Can I do anything for you?"—*Cures tuam fidem*, "preserve your character," i.e., "don't undeceive for the present the people who believe you are acting basely." *Fidem* may be used in a bad as well as a good sense—*Fit sedulo*, lit., "it is being done with care"; translate, "I'll take care."

Sed quid ais? An expression used in colloquial Latin when the speaker wishes to call special attention to some fresh subject he is about to introduce, lit., "but what have you to say on this point"; translate, "But look here."—*Ubi—habet?* "where does he dwell?" *Habet* used for *habitat*.

Recepit, either "he got back," or "he retained." *Posticulum*, "a small back building."

Juxta cum mea, "exactly the same as my own (daughter)."

Rogaturu's, abbreviated for *rogaturus es*.

Argutum. The word is applied to a man, *qui semper arguit*, "who is always wrangling," and may be translated "spiteful, babbling."

Assidui, "gossiping," who take every chance of sitting down together, and pulling their neighbours to pieces.—*Scurras*. This word had not at this period acquired the objectionable force which it had afterwards. At this time it was the usual term applied to the wits and fine gentlemen of the day.

Egomet—traho, "I quite include myself among them, I am just as bad as any of them, because I have lent an ear to their lies."

Habiturust, for *habiturus est*.

Falsone, "they do not care the least (lit., a lock of wool) whether their indiscriminate praise or blame of anyone be false or true."—*Quem velint* is the object of the two verbs *laudent*, *culpent*.

Dum illud sciant, "provided only they know what they please to know."

Evortisset, old form of *evertisset*.

Prosilui—castigatum, "I started forth to accuse." Supine in -*um* after a verb of motion.

Famigeratori res sit, "the talebearer were to be held responsible and suffer damage and loss." A very similar idea is to be found in Sheridan's *School for Scandal*, where Sir Peter Teazle expresses his wish that there was a law passed to punish the originators of all scandalous stories :—

"*Mrs. Candour*. But surely you would not be quite so severe on those who only report what they hear?

"*Sir Peter*. Yes, madam ; I would have law merchant for them too ; and in all cases of slander currency, whenever the drawer of the lie was not to be found, the injured parties should have a right to come on any of the indorsers."

Faxim, for *fecerim*, "I'll be bound."—*Qui sciant*, "I'll be bound we should have very few knowing (i.e., saying they know) what they don't."

KEY TO EXTRACTS.

OVID. "NUX ELEGIA," 1—20.

A walnut tree hard by the roadside, I get pelted with stones by the passers-by, though my life is faultless. Such a penalty is wont to be inflicted on detected criminals when the people's wrath brooks not slow delay. I have done no crime, unless for a tree to bear yearly fruit for its owner is thought to be a crime. In days gone by, when times were better, the trees would vie with each other in fertility, and their thankful owners, at the ripening of the crops, would wreathe with garlands the statues of the gods of husbandry. Thus hast thou often, Bacchus, admired the vine sacred to thee, and Minerva has admired her own olive ; and it has been that the light fruit would have broken the parent tree had not a long forked pole helped the bough to bear the weight.

TACITUS. "ANNALS," IV. 1.

The consulate of C. Asinius and C. Antistius was the ninth year of the reign of Tiberius, and during the whole of it he saw the State undisturbed, his family prosperous, for he regarded the death of Germanicus as a piece of good fortune ; but now, on a sudden, fortune began to work confusion. Tiberius began to be tyrannical, or to encourage others in a similar course The cause of this change was attributable to Ælius Sejanus, commander of the Prætorian guards, whose influence I have already noticed, and will now proceed to unfold the particulars of his birth, his character, and the crime by which he sought to seize the reins of government. He was born at Vulsinii, his father Seius Strabo being of the equestrian order ; and in early youth he attached himself to Caius Cæsar, the grandson of the deified Augustus. Soon after this he gained such an ascendancy over Tiberius by various artifices, that he made him (though so close and mysterious with others) throw off all restraint and reserve with him ; and this he achieved, not by superior cunning, for in this Tiberius was fully his match, but rather by the displeasure with which the gods regarded the empire of Rome, to which he was equally fatal both at the height of his power and in his death. In person he was hardy, and capable of enduring fatigue ; daring in spirit, clever in disguising his own crimes, and prompt to spy out the faults of others ; at once fawning and imperious, and while he preserved an exterior of assumed modesty he was in his heart insatiably lusting for supreme power. With this view he indulged in profusion, liberality, and luxury, but more often gave his mind to careful vigilance—habits no less dangerous when they are counterfeited by ambition for the purpose of gaining supreme power.

JUVENAL. "SAT.," I. 81—116.

From the time when the winds tossed up the sea so high, and Deucalion scaled the mountain in his ship, and asked for an answer from heaven, and by degrees the stones grew soft and warm with life, and Pyrrha displayed to the males the maidens in beauty unadorned—whatever men have done and are doing from that time to this—their prayers, their fears, their angers, their pleasures, and their joys—are the motley contents of our treatise. And at what time has there ever been a finer crop of vices? When has avarice been more greedy, or the dice had such power? For now they are not content to risk the hazard of the gaming-table with their purse alone, but they stake the money-chest and play for it. What battles will you see there, while the steward supplies the weapons! Does it not show simple madness for a man to be content to lose a hundred sesterces, and not give back his coat to the poor shivering slave?

LIGHT.—IV.

[*Continued from p.* 242.]

THE BENDING OF LIGHT.

THE preceding lessons have dealt with light in one medium, viz., air, but as we can see things in transparent substances like water, we have now to inquire how light behaves in passing from one medium into another, as from water into air, or *vice versâ*. That it is a subject for inquiry is evident at once in the following simple experiments. Put a spoon in a glass of water and take a slanting side view of it : the spoon appears bent. Under the same conditions an oar resting in its rowlock, with part of it in the water and part out, looks as if it were bent where the water and air meet. Again, place a coin at the bottom of a mug and move the vessel just sufficiently away so that the coin is no longer visible in the place where it rests. Without moving the vessel or the eye, fill up the mug with water ; the coin comes in sight. We have seen that in air light proceeds in straight lines ; so it does in other media of uniform density, but in passing from one medium to another it is bent, and it is this bending of the rays of light which enables us to account for the foregoing appearances.

THE MUG EXPERIMENT.

If the eye be fixed at *e*, the coin placed at *c* cannot be seen, for the opaque side of the mug is between the eye and the object (Fig. 31). Upon filling the mug with water, however, the coin appears to be at *c′*, or somewhere in the direction of the line *e b*.

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THE SPECTRE OF THE BROCKEN

Draw the perpendicular *a b* from the point *b* where the light from the coin emerges on its way to the eye at *e*. Continue *a b* to *d*, and also join *b e*.

A ray of light reflected from the coin *c* takes the path *c b e* on its way to the eye and is bent at *b*.

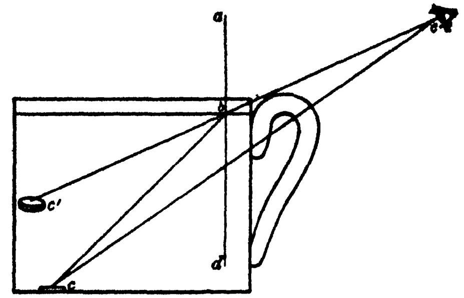


Fig. 31.

As it emerges from the water in the direction *b e* the position of the coin is judged to be in the direction *e b*, viz., at *c'*. The ray of light is therefore bent or broken in this experiment, or what means the same thing, it is *refracted*. This bending or breaking of light is usually termed *refraction*.

The apparent bending of the spoon and of the oar when they dip in water is similarly explained by supposing that light is refracted in passing from one medium into another.

ACTION OF A PRISM OF GLASS ON LIGHT.

When a ray of white light, *e.g.* sunlight, enters a prism of glass (Fig. 32) it is refracted, and after passing to the opposite face of the prism it emerges still further bent out of its original course. Glass lustres of triangular section are suitable for illustrating this fact, though prisms of highly polished glass made specially for the purpose are more suitable. If the refracted ray be received on to a sheet of white paper it is found to be spread out and no longer white, but of a series of colours, from red to violet, all merging imperceptibly into each other. The colours are the colours of the rainbow, in this order: red, orange, yellow, green, blue, indigo, and violet, and they are the colours which constitute white light. It is to Newton that we owe the discovery of the composition of white light. He admitted a beam of sunlight S A (Fig. 33) through a hole in the window-shutter of a darkened room, and received the sunbeam on to a prism P, with the result that the refracted beam was cast on to the opposite wall split up into the rainbow colours we have just mentioned. The experiment is usually performed in the lecture-room by using the oxy-hydrogen lantern and a bottle prism. The bottle prism is a glass bottle with two sides inclined at an angle, and it is filled with a liquid called carbon bisulphide, a badly smelling and highly inflammable substance. The beam from the lantern is passed through the bottle prism, and the refracted light emerges split up into its constituent rays, which are cast on to a white screen. The band of coloured light is called a *spectrum*, and the splitting up of the beam of light by means of the prism is termed *dispersion*.

Fig. 32.

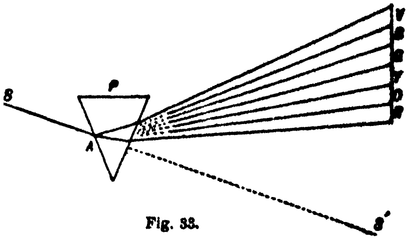


Fig. 33.

It is apparent that the different kinds of light which constitute white light are refracted to different degrees; red is least refracted from its original course, and violet is most refracted—in other words, the least refrangible constituent of white light is red, and the most refrangible is violet—the refrangibility of the other constituents being between these two extremes in the order of their position in the spectrum between red and violet.

If the refracted beam of light after passing through one prism is caught on another in the *reverse* position, the decomposed beam from the first prism is combined again by the second as it emerges, and a white light is cast on the screen instead of a spectrum. Therefore the prism enables us not only to split up white light into its constituent colours, but also to take these coloured constituents and recombine them to form white light again.

THE DISPERSION OF LIGHT.

The dispersion produced by one prism may be increased by causing the refracted light to pass through another similarly placed, and so on through a whole series. Such an arrangement of prisms constitutes a battery, and the length of the resulting spectrum is very much increased. The substances from which prisms are made vary in their dispersive power; thus carbon bisulphide in a bottle prism will produce a greater length of spectrum than a pure glass prism of equal size and similar shape.

THE SPECTROSCOPE AND ITS USE.

If we substitute a narrow vertical slit for the hole in the shutter, and a tube blackened inside for the darkened room, this tube having the slit at one end and a convex lens at the other close to a prism, we get an instrument with which we can try the foregoing experiments on a small scale—we have, in fact, a spectroscope (Fig. 34). The finished instrument consists of a prism P, and a tube *sl* with a very narrow adjustable slit at S and lens at *l*. Suppose you have a candle flame in front of the slit at S, a thin beam of light is admitted into the tube, and the lens at *l* directs it in a parallel state on to the prism P, where it is refracted into a tiny spectrum which could be seen by looking into the face of the prism at P. There is, however, a telescope L for magnifying this spectrum. With such an instrument one can study all kinds of light and the action of coloured transparent bodies on the light. The light of the candle gives a continuous spectrum, *i.e.*, there is no break in the band of light from red to violet. The candle spectrum is rather weak in light at the violet end. The light of the sun when examined by the spectroscope is seen to stretch from red up to the violet, the violet end of the spectrum being quite intense, but along the whole length of the spectrum vertical dark lines are seen, so that the spectrum of the sun is not a continuous one. These dark lines are termed Fraunhofer lines.

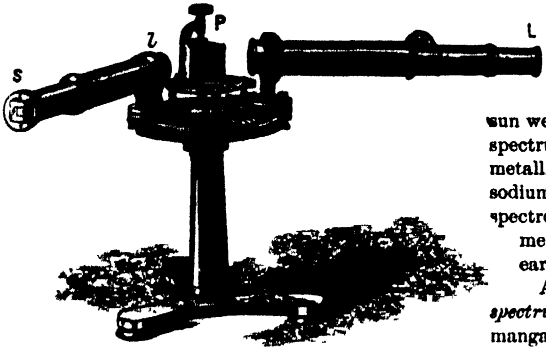


Fig 34.

SOME LESSONS OBTAINED WITH THE SPECTROSCOPE.

All luminous bodies do not emit the same kind of light. (*See Coloured Plate, Frontis.*, Vol. IV.) We have seen there is a difference between sunlight and candle-light in the brightness of the violet end of the spectrum, and also in the fact that while one gives a continuous spectrum the other is interspersed with dark lines. Compounds, like common salt, which contain the metal sodium, yield a spectrum with a golden yellow line; all the rest is blank. It is spoken of as the D line. By increasing the dispersive power of the prism, the yellow sodium line may be resolved into two which are referred to as $D_{\prime}$ and $D_{\prime\prime}$. In the spectrum of the sun this identical line is seen, but it is *dark* instead of bright. The dark line is spoken of as the reversed D line. This reversal of the D line may be obtained artificially by causing light which yields a continuous spectrum to pass through sodium vapour. The inference, therefore, is plain. In the sun we have a central body yielding a continuous spectrum surrounded by highly heated vaporous metallic clouds, one of the metals present being sodium. By similar reasoning, founded on laborious spectroscopic work, we conclude there are other metals in the sun which are also found on the earth. (*See Coloured Plate, Frontis.*, Vol. IV.)

Another kind of spectrum is the *absorption spectrum*. If a pink solution of Condy's Fluid (permanganate of potash), in a thin glass test tube, be put in front of the slit of a spectroscope so that the light of a paraffin-oil lamp or of a gas flame may pass through it before entering the spectroscope, we do not see a continuous spectrum, which would be the case if we were examining the light alone, but we see a spectrum in which four regions are robbed of their light. These dark vertical spaces are called absorption bands, and they always occupy the same positions for this substance, so that a solution of permanganate of potash could be identified by means of the spectroscope among any number of similar pink solutions of other bodies. There is a trace of a fifth band. A great number of substances have characteristic absorption bands, and when this is the case they may be identified by means of the spectroscope. Blood, for example, is one of these, and the spectroscope has been used for identifying it in criminal investigations.

THE INDEX OF REFRACTION.

Let us now return to the diagram of the experiment on refraction with the coin in the mug. If a point of light were at *e* (Fig. 35), its rays would spread in every direction, and some would fall on the surface of the water at the point *b*, part being reflected and part refracted in the direction *b c*; the angles made with the perpendicular line *a d* are named respectively the angle of incidence, *a b e*, and the angle of refraction, *d b c*. There is a constant ratio or proportion existing between the sines of the two angles. The word sine is a trigonometrical term, but the reader may understand what is here meant with the following explanation. Make *b e* equal in length to *b c*; from *e* draw *e a* at right angles to *a d*; and from *c* draw *c d* at right angles to *a d*. The sines of the angles *a b e* and *c b d* are equal to *a e* and *c d* respectively, and the number obtained by dividing the length of *a e* by the length of *c d* is a constant one which when the ray of light passes from air into water is 1·336. This number is termed the *index of refraction*. As the angle *a b c* gradually enlarges, *c b d* also increases so as to preserve the constancy of the ratio or proportion between *a e* and *c d*.

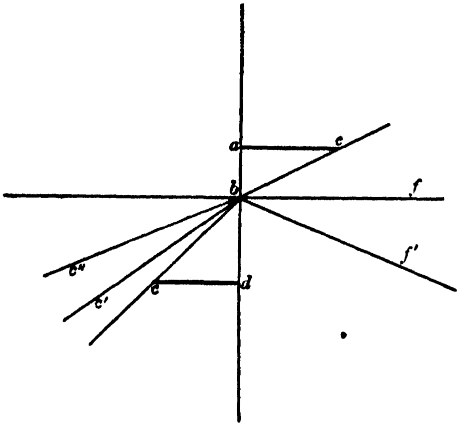


Fig. 35.

TOTAL REFLECTION.

Now the angle *a b e* may gradually increase until it is a right angle, but the angle of refraction will be less than a right angle. Observe what follows from this fact. Take a converse case, and suppose the light is at *c*, and a ray proceeds in the direction *c b*, it will emerge at *b* in the direction *b e*; if the light proceed from *c'* in the direction *c' b* it will emerge in a direction nearly coincident with the surface *b f*, but if the light proceed from the point *c''* in the direction *c'' b* it cannot emerge at all, but is reflected in the direction *b f'* so that the angle of incidence *c'' b d* is equal to the angle of reflection *d b f'*; in short, the ray *c'' b* suffers total reflection. This may be demonstrated experimentally as follows:—Fill a flask with water to the level *b* (Fig. 36); let it rest on a corner of the table with a candle placed below it in the position *c*; the eye at *a* sees the image of the candle reflected from the surface of the water, or if a looking-glass be placed at *a* the eye at *e* sees the image after two reflections, one of which is from the water in the flask.

Total reflection plays a part in a great variety of phenomena, and is exhibited in a marvellous manner in the gorgeous displays of coloured fountains which have been shown at exhibitions in London and Paris in late years. Here coloured light directed into the ascending jets of water illuminates them in their whole course, and as the colour of the light sent into the jets may be quickly altered by the interposition of coloured plates of glass at the source, the fountains are made to assume all sorts of pleasing colours at short intervals. The light is kept within the columns of water by total reflection.

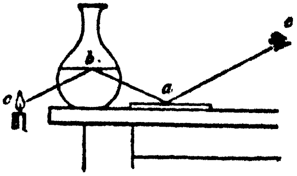


Fig. 36.

THE ACTION OF A RAINDROP ON LIGHT.

When a ray of white light enters one side of a raindrop, it may suffer either one or two total internal reflections, and also be split up into its constituent colours on emerging. The reader may demonstrate this with a flask of plain uncut glass filled with water. It is hardly necessary at this stage to point out that if the surface of the flask be in any way ornamented it will not do for the purpose. One of the kind of flasks used for chemical experiments will do admirably. The flask filled with water represents our raindrop. Our source of light may be a candle or a paraffin-oil lamp. Place the flask filled with water in a position A B C, and the lamp at L (Fig. 37). Upon taking up a position at E to the right of L and examining the flask one sees two images of the light reflected from the back surface of the flask, and it is the brighter of the two which claims our attention. It is coloured

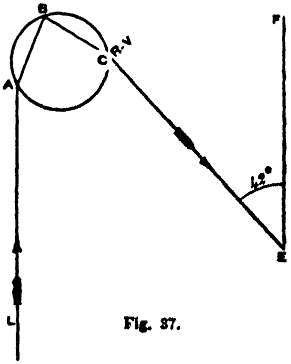


Fig. 37.

red on the left-hand side, and violet on the right-hand side when regarded from the point E, *i.e.*, a position such that the emergent rays C E make an angle of 42° with the line E F which has been drawn parallel to L A, the direction the lamp rays take before entering the flask. That L A is the direction of the rays which make the coloured image may be easily proved by covering the edge of the flask at A with an opaque object, say a book, when the coloured image can no longer be seen at E. Besides diverting the ray L A in the direction C E the flask of water also acts as a prism and breaks it up into its constituent colours.

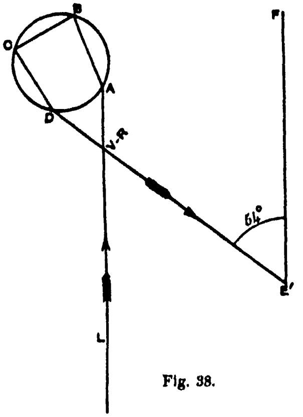


Fig. 38.

Next examine the left-hand side of the flask for a coloured image. When the eye is at E′, Fig. 38, a position in which the line E′ F, parallel to the lamp rays L A, makes an angle of 54° with the emergent rays D E′, an image is seen on the left-hand side of the flask, which is violet to the right and red to the left of it. This image has been formed by the rays L A entering the flask at A, suffering two total reflections at B and C, finally emerging at D in the direction D E′. Correctly regarded, these experiments represent the action of a sphere of water enclosed in a shell of glass, and the latter has some measure of confusing action; they will, however, enable the reader to grasp better the explanation of rainbow phenomena.

RAINBOWS.

The aërial coloured arch which in all ages has occupied the thoughts of philosopher and poet is an optical phenomenon which we shall now be able to understand. As an observer sees a rainbow he stands with his back to the sun; in front of him rain is descending where the coloured bow is seen, and the bow is red on its outer margin and violet on the inner, with the usual colours of the spectrum between; indeed, it might be described as a tremendously tall spectrum, such as one sees in the spectroscope, bent over into the form of an arch. This is termed the primary bow. There is also often seen at the same time an outer bow fainter in aspect, and with its colours reversed, *i.e.*, the outer part of the arch is violet and the inner red. This is termed the secondary bow, and it is concentric with the primary.

We may now combine the two preceding diagrams into one, only let the reader consider A B C and A B C D as raindrops instead of flasks of water. A little thinking will render it apparent that all drops in the dotted arch C I will yield spectra of all the sun's rays coming in the direction L A, as these rays are practically parallel and the coalescence of their spectra will form one grand coloured arch, red on the outside and violet on the inside—the primary rainbow in fact. This in effect is the explanation of the formation of the primary rainbow offered by the philosopher Descartes in the early part of the seventeenth century. His explanations also extended to the secondary bow, which he regarded as being formed by the rays of the sun, L′A, Fig. 39, entering raindrops in the position A B C D, and after suffering two total reflections and two refractions, being directed to the spectator at E, the emergent rays D E making an angle of about 54° with the line E F. And all raindrops in the arch A II would yield the same effect, and collectively produce the secondary bow, violet on the outside, and red on the inside.

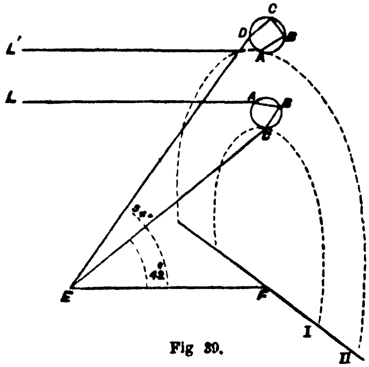


Fig 39.

Simple as this phenomenon now appears to us, the space occupied by these articles would be taken up in describing the speculations and attempts at explanation made prior to Descartes' time. One name only need we mention, that of Antonio de Dominis, who appears to have had a correct conception of the manner in which the inner bow is formed, but no just idea of how the exterior bow is produced; hence the credit is generally given to Descartes, who very satisfactorily accounted for the leading facts of both.

EXTRAORDINARY RAINBOWS.

Extraordinary rainbows are seen at rare intervals in which light reflected from a level sheet of water like an arm of the sea or a river plays an important part. What at first sight appears a reflection of the primary rainbow is sometimes observed under favourable circumstances. Thus Crookes on August 6th, 1877, standing on the end of Eastbourne Pier, saw the usual aërial rainbows, and what looked like a reflection or image of the primary in the water; the legs of the reflected bow, however, did not coincide with those of the primary in the air and were evidently not a reflection of it. What an observer sees on such occasions is the image of a bow in the water which can only be seen in the air by a person some distance in front of him Thus the observer at O sees a rainbow in the air at C, and also what appears an image of a bow at D (Fig 40).

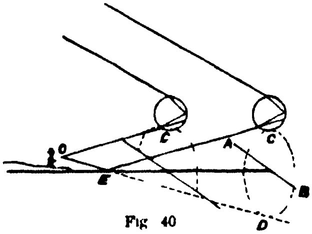


Fig 40

The drops which produce the image at D are in the arch which contains O and in a wrong position for the observer to see the rainbow they produce in the air. This bow could be seen by a person in advance of O and stationed at E; as it is, the observer at O sees the primary at C, and the sheet of water in the plane E A B reflects the light in the neighbourhood of E, so that O also sees a reflected rainbow A D B

A more complicated phenomenon is presented in those cases where non-concentric rainbows are seen Reflection from water also plays a part here, although in a different and more complicated way than that just explained. We shall only briefly describe the phenomena. An observer at Nya in Sweden saw the sight some six years ago. With a sheet of water in front and a brilliant sun behind there appeared the usual secondary and primary bows, and even some supplementary bows within the latter. From the feet of the primary there arose a tertiary bow, with colours in the same order as the primary, and the upper part of its bend coincided to some extent with the upper part of the bend of the secondary bow, and consequently colours were here apparently absent, as the superposition of the two bows with colours in contrary order would give rise to white. A similar phenomenon was seen by Halley in all its completeness on the banks of the Dee towards the close of the seventeenth century. Sometimes it is only seen in part, as, for example, one leg of a primary bow and the corresponding non-concentric part of the tertiary, as was observed by Tait in 1874.

THE ORGANS OF SENSE.—IV.

[*Continued from p. 237.*]

II.—THE EAR (*continued*).

We have to search for the orifice of the ear of birds beneath the feathers. In a few cases, as in the owl and wild turkey, a circle of feathers surrounds the ear-hole, but generally there is no external indication of an ear. On closer examination a zone of fine feathers, with peculiarly fine barbs, through which the air passes readily, is found round the ear. Internally, the ear is not unlike that of mammals, except in the following particulars. The cochlea is rudimentary, that is, it is not developed into a coiled double canal, but is only a slight process from the vestibule, occupied by two cylinders of fine cartilage, representing the two staircases, but of very simple form. The semi-circular canals are similar and similarly disposed, except that two of them, the horizontal and one of the vertical ones, communicate where they cross one another. The most marked difference is that the chain of three ossicles is replaced by one bone, forked at its tympanic end, and stretching right from the membrane of the oval hole to the cartilage of the drum-membrane. The whole organ is very compact, and embedded in bone, and even the canal which runs from the tympanum to open at the top of the throat is of bone.

No one can doubt that the sense of hearing in birds is keen and appreciative. Indeed, if the correlation between the capability of producing a variety of sounds and the appreciation of the same be as close as we should naturally suppose it to be, the sense of hearing in our song birds is most exquisite. If the hen nightingale experiences a corresponding happiness in listening to the song of her mate to that which he evidently feels while his little throat is pouring forth its changeful notes; or if either of them can appreciate the impressions produced by the varied music, ranging as they do from a sweet melancholy to a thrilling joy, then these little summer visitants have an avenue to a constant pleasure, and by the possession of this they make a nearer approach to us than we have been disposed to admit as possible to any of the lower animals. That such should be the case may seem in the highest degree improbable to some minds; yet before it is dismissed as a sentimental fancy it should be remembered that our greatest naturalists hold it as a principle that a species is endowed with no habit or instinct, no product or power, which is solely for the benefit of other species—in fact, that the primary use of every such endowment is for the advantage of the species which possesses it; and if in the great harmony of Nature other species benefit from it, this is incidental, though not accidental. The bee makes honey for its own community, though man and the brown bear despoil its comb. Though leather and fur are so useful and almost indispensable to us, they were more useful and wholly indispensable to the beast that they once clothed. By analogy, therefore (to which there is no counter analogy), when we listen delighted to the strains of the nightingale in May, we may infer that the brooding bird experiences a yet more exquisite delight. So general is this principle, that it is considered certain that every species which produces sounds for its own sake, and disconnected with other necessary movements of the body, also possesses an organ of hearing.

The class of cold-blooded animals called reptiles, which is ill represented except in the tropics, contains creatures of very different structure. The higher of these animals are more like birds than the lower members of their own class, and these again pass through the frogs and toads to fish. Hence, as in the case of the eye, the ear of a typical reptile cannot be described as the ear of the class, because there are such great differences in this organ. Thus, the ear of the crocodile is almost precisely like that of a bird, and it is only in the means of letting the air into the tympanic cavity that there is much difference. The crocodile, though it lives in the water, breathes air, and it is provided with a means of drowning its prey under water while it is itself inhaling the air. This is effected by the channels of the nostrils being carried far back before they communicate with the throat, while a double valve in front of the communication closes and cuts off the throat from the mouth. By holding the prey crossways, and far back against the corners of its widely-gaping jaws, it keeps it under water while its own long snout and nostrils are thrust above the surface. Now we have seen that the tympanic cavity must be supplied with air, and water must be excluded from it; hence the Eustachian tube, or rather complicated system of tubes, is carried backward instead of forward, and opens by a single orifice, behind the hind opening of the nostrils, into the throat, and therefore behind the valve; the opening is on a projection and closed by a half-moon-shaped valve. Every precaution is thus supplied to exclude the water from, and include the air in, the tympanic cavity. Lizards, turtles, and also frogs, have a drum and drum-membrane; but this is on a level with the rest of the skin, so that there is no ear-hole, and in the case of the turtle the drum-membrane is covered by that hard scale which is next but one above the corner of the mouth.

In tracing the organ throughout this class we gradually lose all the outer courts of the ear, and also what remnant of a cochlea was left.

In the bony fishes all these parts are wanting, as might be supposed; but the ear, instead of being brought to the surface, is walled up by the bones of the large skull. If the roof of the skull of a fish be removed, a central compartment will be seen, much too large for the small brain, and on either side, at the back part, a large chamber, which communicates with the central one, and in which the large main portion of the ear is lodged; while the three semi-circular canals springing from this part by dilated bags run, two of them upward into tubular hollows of the skull-bones, and then unite to run into the same vestibular sac by a more central communication; the third is horizontal, and runs outward. The main vestibular sac has itself several compartments which sometimes communicate with it only by narrow constricted necks, and in these are found the otoliths, or ear-stones, which are suspended over the parts to which the strands of the ear-nerve are most largely distributed. These ear-stones are no longer fragmentary particles, as in the case of mammals, or soft chalk, as in the internal ears of frogs, but dense, hard, pearly bodies, one of which is of large size, and is represented in the engraving with its concave streaked side towards the observer, this side being upward when in its natural position.

In illustration of what has been said concerning the advantage of causing the sound waves to be reverberated in air, a peculiar connection between the labyrinth and the internally situated air-bladder of some fish ought to be mentioned. In the carp, each ear-sac sends a passage to a central cavity in the base of the skull, and this has two bags at its hinder end, all filled with fluid, as the cavity of the ear is, and from these a chain of three bones runs to the bladder. In the little fish called the loach, which is one of the first captives obtained by the searcher of the little pools left by the retreating tide, the air-bladder seems to be retained solely to minister to the ear; and in the herring the bladder itself sends processes to be applied to other processes sent to meet them from the vestibule.

In the other great division of fish—distinguished from those just mentioned by the general character of the skeleton, which is not bony, but grisly—from the fact that elastic cartilage is not so resonant a body, and not so good a conductor of sound, as bone, other appliances are given to bring the ear into closer relation to the external water, whence the sounds come. The whole labyrinth is closely surrounded by gristle, and in sharks a canal runs to the top of the head, where it is closed by the skin. In the ray a canal runs from the union of the two semi-circular canals to a similar orifice. Both of these canals are of course filled, not with air, but with fluid, that of the shark being filled with what is called perilymph, or external fluid, and that of the ray with endolymph, or internal fluid.

So much has been conjectured, and so little is really known, about the organ of hearing in the Invertebrata, that it is scarcely advisable to enter upon the subject in a publication like this. The great diversity of sounds produced by insects—some of which, like the cicada (which makes the Italian coppices ring perpetually with its loud grating cry), have very elaborate contrivances for the production of noises—makes it almost certain that this large order of the jointed animals have the sense of hearing. On the other hand, the almost universal muteness of the mollusca might have led us to suppose that the organ of hearing would be wanting to them. Yet, strange to say, while the ears of the cuttle-fish and the slug have been satisfactorily detected, the organ of hearing in insects is still almost unknown. The antennæ, or jointed appendages of the head, have been usually looked upon as the seat of the sense of hearing, but whether it be in the basal joint or the terminal one is a matter of dispute; and in one instance it was supposed to have been found in the hip joint of the front pair of legs—a singular position, it must be confessed. In the lobster or the crayfish it is otherwise; we know what are the requisites of an efficient organ of hearing—hard bodies suspended by threads in a sac containing liquid, and capable of striking upon a nerve filament; this sac must directly or indirectly communicate with the outer world; it may be open, as it is in the lobster, or it may be closed, as in ourselves, by a tympanic membrane. Such an organ is to be seen in the basal joint of the smaller antennæ of a lobster or a crayfish.

It will be seen that much remains to be made out about the ear, and the subject is extremely difficult to study. Indeed, some of the most perplexing problems of the comparative anatomist seem to be associated with the ear. One of the problems may thus be propounded:—What structures in the fish are the representatives of the ossicles of the tympanum called the hammer (*malleus*) and anvil (*incus*) in the mammal? To this question various answers have been given, and the subject is still one which requires much further study.

The temporal bones — which in man lodge the internal and support the external ears, and, besides these functions, close in the brain-case at the sides, send out strong buttresses forward to strengthen the bones of the face, and others to sling the throat bones upon, and also give attachment to the lower jaw—are the most difficult bones in the body to describe and remember. Many vessels and nerves enter them by numerous holes, and these subdivide and find their way out in such strange ways that many a poor medical student has trembled when, in an examination, a temporal bone has been placed in his hand.

III.—THE ORGAN OF SMELL.

In the preceding articles on the organs of sight and hearing it was remarked that while the sensations excited through their agency were so different, the external causes which operated on the eye and ear respectively were not dissimilar. Rapid vibrations, propagated by bodies themselves in violent but otherwise unnoticed vibration, are conveyed through intervening media for great, and, in the case of light, unlimited distances, by waves which are capable of indicating the direction from which they proceed. These vibrations, therefore, can inform the mind concerning objects far removed from its instrument, the body, with an accuracy which makes us scorn the idea that we can be deceived in that which our eyes have seen and our ears heard. Through these avenues the human mind extends itself, till it touches, and by the aid of reason may be said to grasp, the universe; and the highest powers of the mind are employed in interpreting the messages brought to us by light and sound.

In marked contrast to these are the remaining senses of which we have to write—namely, those of smell, taste, and touch. These senses are excited by material particles applied directly to those parts of the body which can take note of their peculiar qualities, and hence they are far less necessarily connected with mental operations. Their uses have more relation to our animal than to our intellectual life, and the appetites which arise from a desire to gratify these senses have always been considered to be less refined and more sensual than those which pertain to the senses of sight and hearing. It is true that a spurious delicacy and refinement of the sense of smell have caused the wealthier classes in times of high civilisation to delight in costly and rare essences and scents; but the extensive use of these has been the characteristic of effeminate races, and of times when civilisation, in its highest sense, had begun to succumb to luxury. When Rome boasted of her costly perfumes, she had almost ceased from the prouder boast of being mistress of the world; and the more manly tone of modern and western society has decided between Hotspur and the fop to the prejudice of the latter.

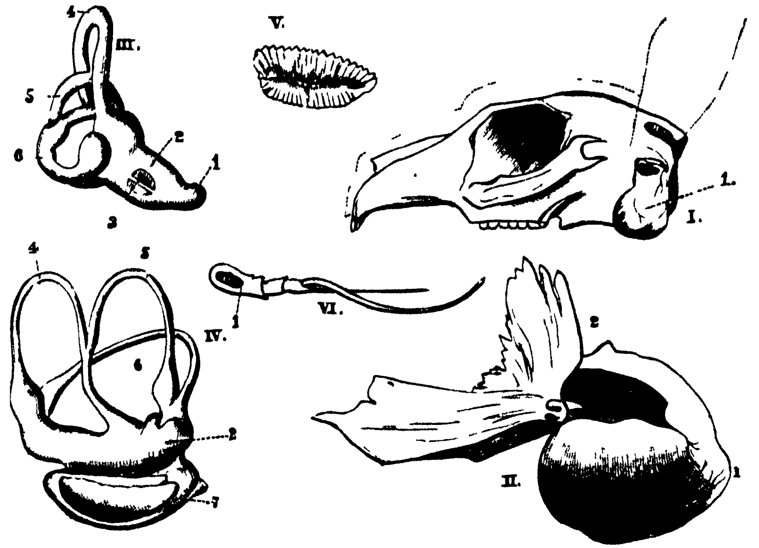


Fig. 8.—I. Side-view of Skull of a Rabbit II. Side-bone of Skull of the Whalebone Whale, one fourth natural size. III. Internal Ear of a Bird IV. Ear of a Cod. V Ear-stone of Cod. VI. Under side of Long Antenna of a Lobster.

Ref. to Nos. in Figs.—I 1, external bony passage to the ear. II 1, tympanic bone; 2, its point of attachment to the skull. III., IV. 1, cochlea, 2, vestibule, 3, oval hole, 4, 5, 6, semi-circular canals. VI. 1, antennule of crayfish with opening into ear-sac in the basal joint.

Matter or material substances exist in three forms—the solid, liquid, and gaseous; and almost all substances can be made to assume each of these forms. Thus ice may be transformed into water and into steam. When the particles of matter hang together so tightly and rigidly that they will not move over one another without the application of force, they form a solid. When the particles hang together so loosely that they will move over and round each other with the slightest force, so that they can scarcely be said to hang together at all, the substance is called a liquid. When the particles not only do not hang together, but exert a force to fly off from one another, the substance they form is called a gas. The sense of touch, strictly and properly defined—that is, excluding the sensation of heat and of resistance—has to do with solids. The sense of taste has to do with liquids only, as nothing is sapid which is not liquid or capable of being dissolved. The sense of smell occupies itself with gases; for these alone can gain access to the organ, or cause the sensation of smell. Lest the reader should suppose this statement opposed to the testimony of his experience, from the well-known fact that solids, such as cedar-wood, camphor, and musk, excite the sensation of smell, while ordinary scents are preserved and carried about in a liquid form, it must be explained that these substances contain volatile essential principles which on free exposure to the air are slowly given off in a state of vapour. Some solids give off particles of their substance in a state of vapour without first becoming liquid, as is ordinarily the case. Thus snow, which coats the earth in winter, will diminish daily, even though the air is frosty, and there is no melting process going on. In other cases, as in cedar-wood, oils naturally volatile seem to be long entangled in the solid matter, and but slowly rendered to the air; but their odoriferous power is so great that very small portions of them produce strong perfumes. This is sometimes truly wonderful. Dr. Carpenter states that a grain of musk may be freely exposed to the air for ten years, during which time it perfumes the whole surrounding air; yet, when weighed, there is no perceptible loss observed. Matters which exhale odorous emanations are detected at a great distance, from the tendency of gases to pass through and diffuse themselves equally throughout all other gases. Thus, though there be but a very small escape of coal-gas in one part of the room, it soon announces itself to the nose in every corner of the apartment. This is a faculty peculiar to gases, and produces many interesting results, which, however, cannot now be dwelt upon.

MINERALOGY.—III.

[*Continued from p.* 221.]

CRYSTALLOGRAPHY (*continued*)—THE CLASSIFICATION OF MINERALS.

THE *Hexagonal system*, being that in which water (H$_2$O), quartz (SiO$_2$), calcite (CaCO$_3$), hæmatite (Fe$_2$O$_3$), corundum (Al$_2$O$_3$), graphite (C), apatite, cinnabar (HgS), emerald, and tourmaline crystallise, is obviously one of great practical importance, and is also interesting geometrically and very varied in its forms. Its axes make equal, but not right, angles with one another, and all the parameters are equal. Iceland spar, the purest form of calcite (CaCO$_3$), readily cleaves to the form known as a *rhombohedron* or *rhomb*, which gives the alternative name "rhombohedral" to the system. This form is bounded by six equal faces, each of which has its opposite sides or edges equal, but not all four edges equal. The rhombohedron has thus two opposite solid angles geometrically similar, in that they are each formed by the meeting of three similar edges, or edges formed by planes making the same angle with one another; and, moreover, the three edges meeting in one of these two solid angles are parallel to those meeting in the other. This form has only three planes of symmetry, one passing through each of these three pairs of parallel edges, so that the three planes intersect at angles of 60° in the line joining the two similar solid angles. This line is the morphological and optic axis of the system (Fig. 20).

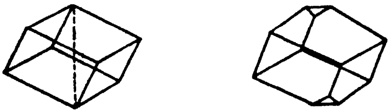


Fig. 20.

RHOMBOHEDRON WITH MORPHOLOGICAL AXIS. RHOMBOHEDRON WITH FACES OF $\{111\}$.

The form $\{111\}$ in this system consists of two parallel faces truncating the two similar solid angles of the rhombohedron. We can obtain these faces by cleavage in calcite. In emerald and apatite, and sometimes in other minerals, we have these two faces naturally developed as the ends of a six-sided prism; and if we look through any transparent crystal of this system in a direction perpendicular to these two faces (parallel, that is, to the optic axis), objects are not doubled, there is no double refraction, such as there is in any other direction. This one direction, or axis, of single refraction, may even be detected in the clear balls of rock-crystal or limpid quartz that are turned by the Japanese; for such turning in no way alters the molecular constitution of the mineral upon which its action upon light depends. Quartz commonly occurs in six-sided prisms terminated by six-faced pyramids (Fig. 21); but these are probably hemihedral combinations, since it may be observed that the lustre of alternate faces of the prism is seldom the same.

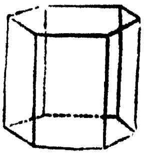


Fig. 21.

Calcite crystallises in an enormous variety of forms, including *scalenohedra*, or forms bounded by twelve scalene triangles meeting in two pyramids or solid angles, six in each. There are also in the system a twelve-sided prism and three-sided prisms and pyramids; whilst snow-crystals present a variety of six-rayed star-like forms. In these more hexagonal forms there are seven planes of symmetry, six intersecting in the morphological axis, the line passing lengthwise down the centre of the prism (joining, that is, the faces of $\{111\}$), at angles of 30°, and the seventh perpendicular to them all (parallel, that is, to the faces of $\{111\}$, or to the "base" of a hexagonal prism). Sections cut parallel to this last plane will give us concentric rings of colour and a symmetrical cross, when examined in the polariscope, as do slices of pyramidal crystals; but such sections will in this case be generally six-, three-, or twelve-sided, instead of four- or eight-sided. Crystals in the Hexagonal system, like those in the Pyramidal, conduct heat as well as light at a different rate in the direction of the morphological axis from that at which it travels in any other direction, and in the same way expand unequally.

In the *Cubic system*, we find in every respect the highest degree of symmetry. The three axes are all at right angles to one another, and the parameters are all equal. There are nine planes of symmetry and no optic axis or double refraction, light and heat being conducted equally in all

directions, and the system is therefore termed—as we saw in a previous lesson—isotropic.

The form $\{1\,0\,0\}$ of this system is the *cube*, a common form in rock-salt (NaCl), fluor (CaF_2), and pyrite (FeS_2). The form $\{1\,1\,1\}$ is the *regular octahedron*, bounded by eight equilateral triangles, represented by diamond and magnetite (Fe_3O_4). Its hemihedral form, as we have seen, $\kappa\ \{1\,1\,1\}$, is the *tetrahedron*. The form $\{1\,1\,0\}$ is the *rhombic dodecahedron*, enclosed by twelve rhombs, as in many garnets. Another dodecahedron, enclosed by pentagons, often occurs in pyrite, either simply or combined with the cube. Another twelve-faced form is the *triakis-tetrahedron*, enclosed by twelve triangular faces, grouped, as it were, in four low, three-sided pyramids on the sides of a tetrahedron. It occurs combined with the cube in boracite, and is the hemihedral form of the *trapezohedron*, which consists of twenty-four trapezoid faces, and occurs in the mineral analcime. Other twenty-four-faced forms, or *icositetrahedra*, are the *tetrakis-hexahedron*, or four-faced cube, resembling a four-sided pyramid on each of the faces of a cube, and the *triakis-octahedron*, resembling a three-faced pyramid on each face of an octahedron. This latter form occurs in the diamond, as does also the *hexakis-octahedron* $\{h\,k\,l\}$, a forty-eight-faced form, which may be considered either as a low pyramid of six triangular faces on the sides of an octahedron, or as an eight-faced one on those of a cube (Fig. 23).

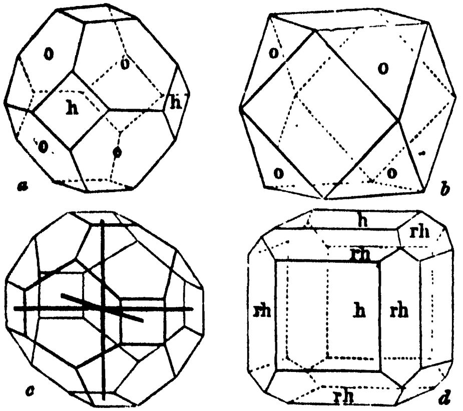


Fig. 22.—*a* and *b*., COMBINATIONS OF THE CUBE AND THE REGULAR OCTAHEDRON. *c* and *d*, COMBINATIONS OF THE CUBE AND THE RHOMBIC DODECAHEDRON.
h, Face of cube. *o*, Face of octahedron. *rh*, Face of rhombohedron.

Besides two or more forms of a system occurring in a combination (Fig. 22), we sometimes find what are termed *twin-crystals* or *macles*. A twin-crystal is a crystal which appears as if cut in half along a particular plane, one half being turned round through two right angles (180°). Selenite, which commonly crystallises in flat rhomboid crystals with bevelled sides, combinations of three forms of the oblique system, also commonly occurs in arrowhead-shaped twins of this form (Fig. 24). Though the term macle is often used as synonymous with twin-crystal, it is more strictly applicable to cases in which two or more similar crystals appear to be mutually intersecting in a constant or symmetrical manner. One of the most striking instances of this is the mineral staurolite, a silicate of aluminium and iron, crystallising in the prismatic system (Fig. 25). Re-entering angles, or angles the apices of which point towards the crystal, are particularly characteristic of twin-crystals and macles.

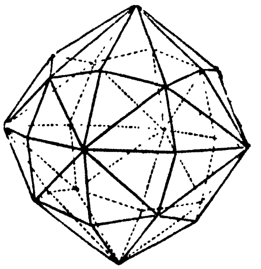


Fig. 23.—HEXAKIS-OCTAHEDRON.

These two lessons will give a sufficient glimpse of the somewhat difficult study of crystallography to enable the student to follow or any ordinary, lessons in mineralogy; but his study will be much facilitated by the use, or still better, the preparation, of models of the crystalline forms. These may conveniently be cut out of large raw potatoes or soft wood. More elaborate models, with coloured wires to show the axes, may be constructed with thin sheet-glass and gummed paper; but perhaps the best method is that of mounting on cardboard and then cutting out and gumming together the plane projections of all the faces of a form, which are known as *nets*.

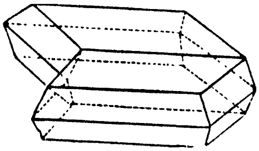


Fig. 24.—ARROWHEAD-SHAPED TWIN OF SELENITE.

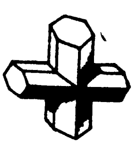


Fig. 25.—MACLE OF STAUROLITE.

Though we cannot as yet explain its exact nature, there is, as we have already suggested, a connection between chemical composition and crystalline form. Most anhydrous sulphates, for instance, crystallise in the prismatic system, baryte, the sulphate of barium ($BaSO_4$) and celestine, that of strontium ($SrSO_4$) occurring in forms differing but very slightly in their angles. Apatite, the phosphate and chloride of lime ($3Ca_3P_2O_8 + CaCl_2$), pyromorphite, the phosphate and chloride of lead ($3Pb_3P_2O_8 + PbCl_2$), and mimetite, the arseniate and chloride of that metal ($3Pb_3As_2O_8 + PbCl_2$), similarly all crystallise in nearly identical forms belonging to the hexagonal system. This is termed *isomorphism* (Greek *ἴσος*, *isŏs*, equal; *μορφή*, *mŏrphē*, form), and may be stated as a law, that substances of analogous chemical constitution, whose molecules, that is, are supposed by chemists to be built up of similarly grouped atoms, crystallise in nearly identical forms. Chemical elements or radicals, which are thus capable of replacing one another in a mineral without affecting its general form, are sometimes termed *vicarious* substances. Thus, fluorine may replace the chlorine in the three minerals last named · sulphur and selenium; arsenic and antimony; cobalt, iron, and nickel; calcium monoxide (CaO) and magnesium monoxide (MgO); the monoxides of iron, manganese, and zinc; the sesquioxides of iron (Fe_2O_3), manganese (Mn_2O_3), chromium (Cr_2O_3), and aluminium (Al_2O_3); phosphoric, arsenic, and vanadic acids in similar salts; sulphuric and chromic acids;—each form a group of vicarious or mutually replaceable substances.

We have already referred to several instances of the converse fact that, not only are most mineral substances known both in a crystalline and a non-crystalline form (the latter commonly assumed on more rapid cooling or precipitation), but many substances are capable of assuming two or more distinct sets of crystalline forms—forms, that is, often belonging to distinct crystalline systems. This is termed *polymorphism* (Greek *πολύς*, *pŏlus*, many; *μορφή*, *mŏrphē*, form). Sulphur, for instance, crystallising naturally in prismatic octahedra, when fused cools into needles belonging to the Oblique system, and is thus *dimorphic*. So, too, carbon crystallises in the Cubic system as diamond and in the Hexagonal as graphite; whilst calcium-carbonate ($CaCO_3$) crystallises in the Hexagonal system as calcite when precipitated from a cold solution, and in the Prismatic system as aragonite when precipitated from a boiling solution. Titanium-dioxide (TiO_2) is *trimorphic*, crystallising in three sets of forms—Prismatic as brookite, and Pyramidal as rutile and anatase.

Some specimens of crystals are rather misleading in that they present a form belonging to some chemical compound, some mineral species, other than their own. Such specimens are termed *pseudomorphs* (Greek *ψεῦδος*, *psĕudŏs*, deceit), and are due either to the encrustation, alteration, or replacement of the original mineral. Encrustation-pseudomorphs, or *epimorphs* (Greek *ἐπί*, *ĕpi-*, upon) as they are sometimes called, are merely crusts of one mineral surrounding either the crystals of another species or the hollows from which such crystals have been dissolved away Quartz often in this way encrusts calcite, fluor, or baryte.

Alteration-pseudomorphs are due either to the loss of a chemical constituent (*katogenic*), as in the reduction of cuprite (copper-oxide, CuO) to copper, or augite to steatite; to the gain of a constituent (*anogenic*), as in the conversion of cuprite into malachite ($CuCO_3 + CuH_2O_2$) by the addition of carbon-dioxide and water, or of galena (lead-sulphite, PbS) into anglesite (the sulphate, $PbSO_4$); or to an exchange of constituents, as when galena replaces pyromorphite, the phosphoric acid and chlorine of the original substance being exchanged for sulphur.

In replacement-pseudomorphs one substance has been entirely removed and the cavities left by its crystals filled with a second substance, which is said to be *pseudomorphous after* the first. Thus, our valuable deposits of hæmatite (Fe_2O_3) at Ulverston are pseudomorphous after calcite ($CaCO_3$). Such pseudomorphs will commonly have blunted angles. The facts of *pseudomorphism* are instructive as to the origin of many species of minerals from the decomposition of others. Fossils may be considered in many cases as mineral pseudomorphs after organic matter.

The most satisfactory method of classifying the many different kinds or species of minerals that exist, so as to bring together isomorphous groups and suggest much as to their origin and the relation of their form to their composition, is one based primarily on chemical composition, and giving more prominence to what chemists term the acid constituents of compounds than to their bases.

Dealing only with the more important of the many hundreds of species that have been described, but which are in many cases merely scientific curiosities, we shall distribute them into five main groups or divisions, viz.:—

1. Native elements.
2. Compounds of metals with sulphur, arsenic, antimony, etc., or, briefly, sulphides and arsenides, mostly binary compounds with sublimating diads. (*See* lessons on Chemistry.)
3. Compounds of metals with chlorine, fluorine, etc., or, briefly, chlorides, binary compounds with the halogen monads.
4. Oxides, compounds of metals with oxygen, in some cases hydrous.
5. Oxygen-salts, compounds of metals with oxygen, in which the metal replaces the hydrogen of an acid, also sometimes hydrous.

The first division is subdivided into the metallic class of elements and the non-metallic class; whilst the fifth, by far the largest, division includes seven classes :—(i.) carbonates ; (ii.) silicates ; (iii.) tungstates, etc. ; (iv.) sulphates and chromates ; (v.) borates ; (vi.) nitrates ; and (vii.) phosphates, arseniates, etc.

This classification is virtually that published by Gustav Rose in 1852, and adopted in the arrangement of the magnificent collection of the British Museum in the Natural History Museum in Cromwell Road, South Kensington.

Before proceeding to speak of the various groups and species, it may be useful to point out that, though exceptions are numerous and often difficult of explanation, native metals, binary salts of the halogens (chlorides, etc.), and protoxides mostly crystallise in the Cubic system ; dioxides, often in the Pyramidal ; sesquioxides, phosphates, arseniates, vanadiates, etc., in the Hexagonal ; carbonates, in the Hexagonal or Prismatic ; and anhydrous sulphates, seleniates, chromates, etc., in the Prismatic. When a compound is dimorphous, one form seems generally to belong to the Prismatic system.

SPANISH.—VII.

[*Continued from p.* 246.]

CONJUGATIONS OF REGULAR VERBS

It has been already mentioned that there are in Spanish three conjugations : the first comprehending verbs whose infinitive ends in *-ar ;* the second, those ending in *-er ;* and the third, those ending in *-ir*.

Every verb consists of two parts—the ***root*** and the ***termination***, or the ***verb-root*** and the ***verb-ending***. The verb-root consists of those letters which are not changed by inflection ; as *am-* in *am-ár*, *am-o*, *am-ába*, *am-é*, *am-aré*. Those letters which may be changed by inflection, to show the different moods, tenses, persons, and numbers, constitute the verb-endings. Thus, in the preceding examples, the letters, *-ár*, *-o*, *-ába*, *-é*, *-aré*, are the verb-endings.

The following is a tabular view of the verb-endings of all the conjugations. The figures 1, 2, 3, denote the first, second, and third conjugations respectively :—

Conjug.	*Infin. Mood.*	*Past Part.*	*Gerund.*
1.	-ár	-ádo	-ándo
2.	-ér	-ído	-iéndo
3.	-ír	-ído	-iéndo

INDICATIVE MOOD.

Present.

	SINGULAR.			PLURAL.		
Conj.	1 *Per.*	2 *Per.*	3 *Per.*	1 *Per*	2 *Per.*	3 *Per.*
1.	-o	-as	-a	-ámos	-áis	-an
2.	-o	-es	-e	-émos	-éis	-en
3.	-o	-es	-e	-ímos	-ís	-en

Imperfect.

	SINGULAR.			PLURAL.		
1.	-ába	-ábas	-ába	-ábamos	-ábais	-ában
2.	-ía	-ías	-ía	-íamos	-íais	-ían
3.	-ía	-ías	-ía	-íamos	-íais	-ían

Perfect Definite.

1.	-é	-áste	-ó	-ámos	-ásteis	-áron
2.	-í	-íste	-ío	-ímos	-ísteis	-iéron
3.	-í	-íste	-ío	-ímos	-ísteis	-iéron

First Future.

1.	-aré	-arás	-ará	-arémos	-aréis	-arán
2.	-eré	-eras	-erá	-erémos	-eréis	-erán
3.	-iré	-irás	-irá	-irémos	-iréis	-irán

IMPERATIVE MOOD.

1.	-e	-a	-e	-émos	-ád	-en
2.	-a	-e	-a	-ámos	-éd	-an
3.	-a	-e	-a	-ámos	-íd	-an

SUBJUNCTIVE MOOD.

Present.

Conj.	1 *Per.*	2 *Per.*	3 *Per.*	1 *Per.*	2 *Per.*	3 *Per*
1.	-e	-es	-e	-émos	-éis	-en
2.	-a	-as	-a	-ámos	-ais	-an
3.	-a	-as	-a	-ámos	-áis	-an

Imperfect.

1.	-ára	-áras	-ára	-áramos	-árais	-áran
	-aría	-arías	-aría	-aríamos	-aríais	-arían
	-áse	-áses	-áse	-ásemos	-áseis	-ásen
2.	-iera	-iéras	-iéra	-iéramos	-iérais	-iéran
	-ería	-erías	-ería	-eríamos	-eríais	-erían
	-iése	-iéses	-iése	-iésemos	-iéseis	-iésen
3.	-iéra	-iéras	-iera	-iéramos	-iérais	-iéran
	-iría	-irías	-iría	-iríamos	-iríais	-irían
	-iese	-iéses	-iése	-iésemos	-iéseis	-iésen

First Future.

1	-áre	-áres	-áre	-aremos	-áreis	-áren
2.	-iére	-iéres	-iére	-iéremos	-iéreis	-iéren
3.	-iére	-iéres	-iére	-iéremos	-iéreis	-iéren

CHANGES IN THE VERB-ENDING.

A change takes place in the first letter of the verb-ending in the gerund, in the third person singular and plural of the perfect definite in the indicative, and in all the persons of the first and third forms of the imperfect subjunctive, and in the first future of the same mood, in the second or third conjugation, when the verb-root ends in *a*, *e*, or *u*. This change is merely the substitution of *y* for *i :* as, *ca-ér*, *ca-yéndo*, *ca-yó*, *ca-yéron*, *ca-yére*, *ca-yése*, etc. ; *cre-ér*, *cre-yéndo*, *cre-yó*, *cre-yéron*, *cre-yére*, *cre-yéres*, etc. ; *argü-ír*, *argu-yéndo*, *argu-yó*, etc.

If the last letter of a verb-root be a silent *u*, the change in the verb-ending does not take place ; as, *persegu-ír*, *persigu-iéndo*, etc., and not *persigu-yéndo*.

CHANGES IN THE VERB-ROOT.

In order that the last letter of the verb-root may retain in all tenses the same sound which it has in the infinitive, a change of letters is sometimes required. This change can only take place when the verb-root ends in *c*, *g*, *gu*, or *qu*.

In such cases there is changed, in the *first conjugation*—

c of the verb-root into *qu* before *e* of the verb-ending ; as, *tóc-ar*, *tóqu-e*.

g of the verb-root into *gu* before *e* of the verb-ending ; as, *pág-ar*, *págu-e*.

In the *second conjugation*—

c of the verb-root into *z* before *a* or *o*; as, *venc-er*, *vénz-as*, *vénz-o*.

g into *j* before *a* or *o*; as, *converg-ír*, *convérj-a*, *convérj-o*.

In the *third conjugation*—

c of the verb-root into *z* before *a* or *o*; as, *un-cír*, *unz-as*, *unz-o*.

g of the verb-root into *j* before *a* or *o*; as, *ung-ír*, *unj-a*, *únj-o*.

gu into *g* before *a* or *o*; as, *consegu-ír*, *consig-an*, *consig-o*.

qu into *c* before *a* or *o*; as, *delinqu-ír*, *delinc-as*, *delinc-o*.

The reason for these changes will at once be perceived by the student on his referring to what we have said on the "Sound of the Consonants". thus *c* is sounded like *k* before *a* or *u*, and like *th* before *e* or *i*; while *qu* before *e* or *i* has the sound of *k*. If, then, in conjugating *to-cár* (in the present tense of the subjunctive mood, for example), we retain the *c* in the verb-root, the pronunciation would be altered from the sound of *k* to that of *th*; thus, *to-cár*, pronounced *to-kár*, and *tó-ce*, pronounced *tó-thay*. But by changing *c* into *qu* the hard sound of *c* is retained; thus, *tó-que*, pronounced *tó-kay* And so before *a* or *o*, by changing *c*, *g*, *gu*, and *qu* of the verb-root of the second and third conjugations into *z*, *j*, *g*, and *c* respectively; and *g* of the first conjugation into *gu* before *e* of the verb-ending

The compound tenses are always formed by the different persons of the verb *haber* and the past participle of the verb to be conjugated. The compound tenses are the past infinitive, the gerund of the past, the perfect indefinite, the first pluperfect, the second pluperfect, and second future of the indicative; the perfect indefinite, pluperfect, and second future of the subjunctive. If the student has committed to memory the simple tenses of the verb *haber* he is able to conjugate the compound tenses of any verb in Spanish.

PARADIGM OF THE THREE CONJUGATIONS.

In these model verbs of the three conjugations the persons of every tense are to be accented on the syllable next to the last, except where the marked accent is placed over some other syllable.

INFINITIVE MOOD.

FIRST CONJUGATION.	SECOND CONJUGATION.	THIRD CONJUGATION.
	Present.	
Amár, *to love.*	Comér, *to eat.*	Vivír, *to live.*
	Past.	
Habér amado, *to have loved.*	Habér comido, *to have eaten.*	Habér vivido, *to have lived.*
	Present Gerund.	
Amando, *loving.*	Comiendo, *eating.*	Viviendo, *living.*
	Past Gerund.	
Habiendo amado, *having loved.*	Habiendo comido, *having eaten.*	Habiendo vivido, *having lived.*
	Past Participle.	
Amado, *loved.*	Comido, *eaten.*	Vivido, lived.

INDICATIVE MOOD.

FIRST CONJUGATION.

	Present.		*Perfect Indefinite.*
Sing.	Ame, *I love.*	*Sing.*	He amado, *I have loved.*
	Amas.		Has amado.
	Ama.		Ha amado.
	V ama.		V. ha amado.
Plur.	Amamos.	*Plur.*	Hemos amado.
	Amais.		Habéis amado.
	Aman.		Han amado.
	VV. aman.		VV. han amado.

	Imperfect.		*First Pluperfect.*
Sing.	Amaba, *I was loving.*	*Sing*	Había amado, *I had loved.*
	Amabas		Habías amado.
	Amaba.		Había amado.
	V amaba.		V había amado.
Plur.	Amábamos.	*Plur.*	Habíamos amado.
	Amábais.		Habíais amado.
	Amaban.		Habían amado.
	VV. amaban		VV. habían amado.

	Perfect Definite.		*Second Pluperfect.*
Sing	Amé, *I loved.*	*Sing*	Hube amado, *I had loved.*
	Amaste.		Hubiste amado.
	Amó.		Hubo amado.
	V amó.		V. hubo amado.
Plur	Amamos	*Plur.*	Hubimos amado.
	Amásteis.		Hubísteis amado.
	Amáron		Hubieron amado.
	VV. amáron		VV. hubieron amado.

	First Future.		*Second Future*
Sing.	Amaré, *I shall or will love.*	*Sing*	Habré amado, *I shall have loved.*
	Amarás.		Habrás amado.
	Amará.		Habrá amado.
	V. amará.		V. habrá amado.
Plur.	Amaremos.	*Plur.*	Habremos amado.
	Amaréis.		Habréis amado.
	Amaran		Habrán amado
	VV amarán.		VV. habrán amado.

SECOND CONJUGATION.

	Present.		*Perfect Indefinite.*
Sing	Como, *I eat.*	*Sing.*	He comido, *I have eaten*
	Comes		Has comido.
	Come		Ha comido
	V come.		V ha comido.
Plur	Comemos.	*Plur.*	Hemos comido.
	Coméis.		Habéis comido.
	Comen.		Han comido.
	VV. comen.		VV. han comido.

	Imperfect.		*First Pluperfect.*
Sing	Comía, *I was eating.*	*Sing*	Había comido, *I had eaten.*
	Comías.		Habías comido.
	Comía.		Había comido.
	V comía.		V había comido.
Plur.	Comíamos.	*Plur.*	Habíamos comido.
	Comíais.		Habíais comido.
	Comían.		Habían comido.
	VV. comían.		VV. habían comido.

	Perfect Definite.		*Second Pluperfect.*
Sing	Comí, *I ate.*	*Sing.*	Hube comido, *I had eaten.*
	Comiste.		Hubiste comido.
	Comió.		Hubo comido
	V comió.		V. hubo comido
Plur.	Comimos.	*Plur.*	Hubimos comido.
	Comísteis.		Hubísteis comido.
	Comiéron.		Hubieron comido.
	VV. comiéron.		VV hubiéron comido.

	Future.		*Second Future.*
Sing	Comeré, *I shall eat.*	*Sing.*	Habré comido, *I shall have eaten.*
	Comerás.		Habrás comido.
	Comerá.		Habrá comido.
	V comerá.		V. habrá comido.
Plur.	Comeremos.	*Plur.*	Habremos comido.
	Comeréis.		Habréis comido.
	Comerán.		Habrán comido.
	VV. comerán.		VV. habrán comido.

THIRD CONJUGATION.

	Present.		*Perfect Indefinite.*
Sing.	Vivo, *I live*	*Sing.*	He vivido, *I have lived.*
	Vives.		Has vivido.
	Vive.		Ha vivido.
	V. vive.		V. ha vivido.
Plur.	Vivimos.	*Plur.*	Hemos vivido.
	Vivís.		Habéis vivido.
	Viven.		Han vivido.
	VV. viven.		VV. han vivido.

	Imperfect.		*First Pluperfect.*
Sing.	Vivía, *I was living.*	*Sing.*	Había vivido, *I had lived.*
	Vivías.		Habías vivido.
	Vivía.		Había vivido.
	V. vivía.		V. había vivido.
Plur	Vivíamos.	*Plur.*	Habíamos vivido.
	Vivíais.		Habíais vivido.
	Vivían.		Habían vivido.
	VV. vivían.		VV. habían vivido.

	Perfect Definite.		*Second Pluperfect.*
Sing.	Viví, *I lived.*	*Sing.*	Hube vivido, *I had lived.*
	Viviste.		Hubiste vivido.
	Vivió.		Hubo vivido.
	V. vivió.		V. hubo vivido.
Plur.	Vivimos.	*Plur.*	Hubimos vivido.
	Vivísteis.		Hubísteis vivido.
	Viviéron.		Hubieron vivido.
	VV. viviéron.		VV. hubieron vivido.

	First Future.		*Second Future.*
Sing.	Viviré, *I shall live.*	*Sing.*	Habré vivido, *I shall have lived.*
	Vivirás.		Habrás vivido.
	Vivirá.		Habrá vivido.
	V. vivirá.		V. habrá vivido.
Plur.	Viviremos.	*Plur.*	Habremos vivido.
	Viviréis.		Habréis vivido.
	Vivirán.		Habran vivido.
	VV. vivirán.		VV. habrán vivido.

IMPERATIVE MOOD.

FIRST CONJUGATION.

Sing.	Ame, *let me love* (or *may I love*).	*Plur.*	Amemos, *let us love* (or *may we love*).
	Ama, *love thou.*		Amad, *love ye* (or *you*).
	No ames, *love thou not.*		No ameis, *love you not.*
	Ame, *let him love* (or *may he love*).		Amen, *let them love* (or *may they love*).
	Ame V., *love you.*		Amen VV., *love you.*

SECOND CONJUGATION.

Sing.	Coma, *let me eat* (or *may I eat*).	*Plur.*	Comamos, *let us eat* (or *may we eat*).
	Come, *eat thou.*		Comed, *eat ye* (or *you*).
	No comas, *eat thou not.*		No comais, *eat you not.*
	Coma, *let him eat* (or *may he eat*).		Coman, *let them eat* (or *may they eat*).
	Coma V., *eat you.*		Coman VV., *eat you.*

THIRD CONJUGATION.

Sing.	Viva, *let me live* (or *may I live*).	*Plur.*	Vivamos, *let us live* (or *may we live*).
	Vive, *live thou.*		Vivid, *live ye* (or *you*).
	No vivas, *live thou not.*		No vivais, *live you not.*
	Viva, *let him live* (or *may he live*).		Vivan, *let them live* (or *may they live*).
	Viva V., *live you.*		Vivan VV., *live you.*

KEY TO EXERCISES.

Ex. 23.—1. I am the judge's son. 2. Thou art young. 3. Am I rich? 4. You are young. 5. Peter is robust. 6. This book is Mary's. 7. These forks are of silver. 8. You are a Spaniard. 9. You are Germans. 10. We are Spaniards. 11. You are Englishwomen. 12. They are Englishmen. 13. I am a German. 14. He is a physician. 15. My brothers were hatters, but now they are carpenters. 16. Thou wast a painter. 17. I was a lawyer. 18. They were soldiers. 19. We were shoemakers. 20. You were booksellers. 21. She was not a beauty. 22. Was I not more robust than he? 23. Were they lawyers? 24. You were printers. 25. Man was created. 26. We were punished. 27. Thou wast punished. 28 You were rewarded. 29. You were punished. 30. Was he rewarded? 31. I was young. 32. I have been unfortunate. 33. Thou hast been rewarded. 34. We have been punished. 35. You have been faithful. 36. The lawyer has been unfortunate. 37. I have been happy. 38. My sister had been imprudent. 39. I had been punished. 40. You had been imprudent. 41. They shall be rewarded. 42. My brothers will be lawyers. 43. Mary will be a beauty. 44. I shall be a physician. 45. You will be soldiers. 46. You shall be rewarded. 47. Wine will be cheap this year. 48. They will not be rewarded according to their works. 49. Be good. 50. Be ye punctual. 51. Let us be good and wise. 52. Let the female servants be punished. 53. May you be happy. 54. Let the impious be punished. 55. Let the printer be rewarded. 56. I wish that my friends may be good. 57. I wish that thou mayest be happy. 58. It is possible that thou mayest not be poor. 59. It is possible that John may not be punished.

Ex. 24.—1. Soy soldado. 2. Tu eres abogado. 3. Son jóvenes. 4. Es diligente. 5. Sois negligentes. 6. Es pequeña y linda. 7. VV. son prudentes. 8. ¿Soy yo imprudente? 9. La cuchara es de oro. 10. Las señoras son Francesas. 11. V. es Español. 12. Sois Inglesas. 13. Somos Alemanes. 14. Soy Ingles. 15. Es Española. 16 Son zapateros. 17. Pedro era posadero. 18. Tu padre era panadero, y ahora es librero. 19. Eras médico. 20. Eramos zapateros. 21. Erais abogados. 22. V. era juez. 23. Eran impresores, pero ahora son carpinteros. 24. ¿Mis hermanas no eran tan culpables como ella? 25. Yo era general. 26. Fui castigado. 27. Esta carta fué escrita para mi madre. 28. Fuimos castigados. 29. Fueron premiados. 30. Mi madre ha sido desgraciada. 31. Has sido premiado. 32. Han sido fieles. 33. He sido castigado. 34. Ella ha sido hermosa. 35. VV. han sido premiados. 36. V. ha sido fiel. 37. Habiamos sido imprudentes. 38 V. habia sido premiado. 39. Habíais sido castigados. 40. Juan será soldado. 41. VV. séran premiados. 42. Serás castigado. 43. Pedro será mas rico que Juan, pero Juan sera ménos ignorante que Pedro. 44. La harina será barata. 45. Nunca serás juez. 46. ¿Los criados séran premiados? 47. Los buenos séran premiados. 48. Séd fieles. 49. Se puntual. 50. Séa Juan tan fiel como Pedro. 51. Séan VV. muy felices. 52. Quiero que Juan séa premiado. 53. Quiero que V. séa económico. 54. Muy probable es que nunca séais ricos. 55. Preciso era que fuésen puntuales. 56. Era preciso que no fuésemos negligentes. 57. ¿No sería este librero el mejor de los dos? 58. Si yo fuera rico, yo seria económico. 59. No créo que la madre del médico haya jamás sido linda. 60. ¡Ojalá hubiese yo sido frugal! 61. Quiero ser prudente. 62. El que es mal hijo no puede ser buen padre. 63. Pretende no haber sido engañado. 64. Siendo como eres tan imprudente, ¿quien te dará dinero? 65. ¡Ojalá hubieses sido prudente!

Ex. 25.—1. The Frenchman is in the city. 2. I am in the street. 3. They are contented. 4. You are angry. 5. He is busy. 6. Thou art in thy house. 7. The lawyers are in the hotel. 8. Are you tired? 9. We are not tired. 10. Where is the hotel? 11. It is here. 12. Where is my hat? 13. It is upon the table. 14. Is Mr. B. at home? 15. He is at home. 16. Are you well? 17. We are well. 18. James is in the field. 19. He was ill. 20. I was contented. 21. We were present. 22. They were weary. 23. Thou wast sick. 24. Were you not in the field? 25. Were you there many years? 26. Were they sorrowful? 27. Were you a long time with the judge? 28. How long hast thou been in England? 29. We have never been in England. 30. I have been very ill. 31. John will be in his house. 32. They will be with you presently. 33. Thou wilt be present. 34. I shall be with you soon. 35. Let us be contented. 36. May they be present. 37. Let the water be warm. 38. It is possible that ye may be present. 39. If John should be present, Mary would be pleased. 40. Oh that I had not been sick !

Ex. 26.—1. Estamos tristes. 2. Estais enfadado. 3. Está ocupado. 4. El agua está caliente. 5. Mi padre está en la ciudad. 6. El impresor siempre está ocupado. 7. Siempre estás ocupado. 8. ¿Dónde está el libro de Juan? 9. Aqui está. 10. ¿Dónde estan mis cucharas, cuchillos, y tenedores? 11. Aqui estan. 12. ¿Como está V.? 13. Estoy bueno. 14. ¿Como está la señora B.? 15. Está buena. 16. ¿Como esta la señorita B.? 17. No está muy buena. 18. ¿Está V. cansado? 19 No estoy cansado. 20. ¿Está Pedro en Madrid? 21. No, señor, está en Inglaterra. 22. El libro está sobre la mesa. 23. La señora B. estaba ocupado 24. VV. estaban presente. 25. Estabais presentes. 26. ¿No estaba mi padre en la ciudad? 27. Estabamos en la calle. 28. Estabas con tu amigo. 29. Estuve triste dos años. 30 ¿Estuviste allí? 31. Estuvo allí? 32. Nunca he estado en Inglaterra. 33. Habíamos estádo muy enfermos. 34. Estaré ocupado. 35. Estaremos en nuestras casas. 36. Estaréis presentes. 37. Pedro estará con nosotros luego. 38. Estád contentos. 39 Esté contento. 40. Es posible que Pedro este en su casa. 41. Probable es que los abogados esten cansados. 42. ¡Ojala V. hubiese estado presente! 43. Estando enfermo el juez dio su dinero a sus hijos.

Ex. 27.—1 Tu eres sobérbio 2. Estas enfadado. 3. La muerte es terrible. 4. Estamos en la calle. 5. Mi padre es muy rico. 6. Mi madre está muy triste. 7. El plomo es pesado. 8. La leche está agria. 9. Soy Aleman. 10. Somos imprudentes. 11. Estamos enfermos 12. Ella es vieja. 13. Ella está contenta. 14 Mi madre es ciega. 15. Mi hija es ciega de ira. 16. Maria es hermosa. 17. Lucia está ocupada. 18. Juan es bueno. 19. Juan está bueno. 20. La cuchara es de oro. 21. La cuchara está sobre la mesa. 22 Las medias son de seda. 23. Las medias estan en la calle 24. El libro es para María. 25. El libro está en la fonda. 26. Aqui estan las medias. 27. Mi madre es enfermiza. 28 Mi madre está enferma. 29. Los botones son de plata. 30. Estan escribiendo. 31. El azucar es dulce. 32 Son sabios. 33. Estan tristes. 34. ¿Donde está mi sombrero? 35. Aqui esta

Ex. 28.—1. Have you apples? 2. I have apples. 3. You have chairs. 4. We are hot. 5. They are ashamed. 6. Am I ashamed? 7. Thou art ashamed. 8. Who have pears? 9. My brothers have iron. 10. We have forks. 11. Thou hast knives. 12. What sort of sugar has the villager? 13. She has no husband. 14. We have a house. 15. Have we tables? 16. Hast thou candlesticks? 17. The rose has thorns. 18. You have a memory. 19. Have you soup? 20. We have success. 21. The physician had confidence in the Spanish woman. 22. She had no lamp. 23. I had a rose. 24. They had money. 25. You had a stocking. 26. You had silver. 27. Thou hadst gold. 28. She had prudence. 29. Had I shoes? 30. Had they no tables? 31. He had sugar yesterday. 32 I had buttons yesterday. 33. She had flour yesterday 34. You had money. 35. We had lamps. 36. Thou hadst candlesticks. 37. They had no looking-glasses. 38. Hadst thou a pen? 39. I had a house. 40. We had silk stockings yesterday. 41. She has had two husbands. 42. They have had many cares. 43. I have had no soup. 44. They will have oil. 45. You will be hungry. 46. They will be ashamed. 47. I will have had money. 48. Have peace with all the physician's sons. 49 Let them have honey. 50. May we have looking-glasses? 51. May you have confidence in him. 52. It is possible that thou mayest have oil. 53. I wish that Mary may have money. 54. It is probable that we may have some merit. 55. I wish that you may have candlesticks. 56. It was not strange that I should have money. 57. It was necessary that we should not have sugar. 58. John should have a fork. 59. Oh that I had not had these lamps! 60. If I have patience I shall have success.

Ex. 29.—1. Tienen peras. 2. Tenemos plumas. 3. Ella tiene hambre. 4. Tengo sed. 5. Tengo temor. 6. Tenemos frio. 7. Tenéis una lampara. 8. ¿Quien tiene nueces? 9. Tenéis espejos. 10. ¿Que especie de botones tiene V.? 11. ¿Tenemos marmol? 12. Tengo tres hijos y dos hijas. 13. Tenéis tres hermanos. 14. María tiene mucha confianza en el juez. 15. Teniamos hambre. 16. VV. teniais confianza en mi hermano. 17. ¿Teníamos botas? 18. Tuvieron manteca ayer. 19. Tuvimos calentura ayer. 20. Tuvísteis sillas ayer. 21. El zapatero ha tenido mucho cuidado. 22. He tenido mucho hierro. 23. Has tenido tres hijas. 24. Hemos tenido dos hijos. 25. Maria ha tenido calentura. 26. Habéis tenido mucho dinero. 27. Tendré un candelero. 28. Ella tendrá un tenedor. 29. Tendrás calor. 30 Tendremos sed. 31. Tened paz con todos los hombres. 32. Tenga plumas. 33 Tengan miel. 34. Quiero que mi madre tenga harina. 35. Probable es que tengan lamparas. 36. Quiero que yo tenga medias de seda. 37. Es posible que tengais hambre. 38. No era estraño que tuviesen peras. 39. No era estraño que V. tuviese aceito. 40. Si tuvieses botas, yo tendria zapatos. 41. No creo que Pedro haya tenido manteca. 42. ¡Ojala no hubieran tenido esos libros! 43. Si mis hijos tuvieran paciencia tendran suceso.

COMPARATIVE ANATOMY.—IX.

[*Continued from p.* 252.]

INSECTA (*continued*).

THE reader will probably wonder why the wings have not been spoken of as appendages to the body-rings. He will ask, if the number of so-called appendages is made to determine the number of rings of which the body is composed, why the wings do not count for limbs whereby to determine the number of the annuli of the thorax? A careful comparison of these organs throughout the class, with their mode of development, has led naturalists to suppose that the wings are modified gills corresponding to the gill covers of crustaceans, and not with the limbs of these. If this correspondence be genuine, it is a curious instance of how the same organ may have very different uses in different animals. The skin or integument of insects consists essentially of three layers. The outermost is a thin transparent membrane; beneath this is the hard horny-coloured layer, to the inside of which the live vascular skin is applied. The wing consists of an extension of the outer layer into a long bag, the two sides of which are smoothed down and applied to one another so as to form one sheet, while this is strengthened and kept in shape by a framework of stiff fibres derived from the second layer. Derivatives from the blood system and the respiratory system in some instances enter the fibres, but are not conveyed into the membranous part of the wing, so that the torn wing of an insect is never repaired. The pattern of the framework of fibres, or nervures, as they are called, is well worthy of study, not only because it is beautiful and made much use of in describing and distinguishing insects, but on account of its wonderful adaptation to the requirements of the wing, furnishing strength and resistance where strength and resistance are required. The wings are very variously developed. The fore wings are the most constant and generally the largest, but in some (Strepsiptera) they almost disappear, and in another large order (Coleoptera) they are converted into hard covers for the hind wings, and never employed in flight. The hind wings, though largely developed in the beetle and grasshopper, and quite as large as the fore wings in dragon-flies, are often only adjuncts to the fore wings, being much smaller than these, and fastened to them or dissevered from them as the insect wills. There are various and elaborate contrivances by which this junction of the hind wings to the fore ones is effected in insects. In flies, the hind wings are reduced to little sticks with knobs at the end, and why they should be retained at all in this form is a puzzle to entomologists.

The abdomen or hind division of the body is elongated, and tapering towards the end. It generally consists of nine segments, but the last two or three or four are often reduced in size, and applied, not to contain the viscera, but to purposes of reproduction, defence, etc. Thus, for example, in the bee, the sting consists of two modified rings, and the ovipositor of the saw-fly is of the same nature. The rings of the abdomen are not firmly applied to one another along their edges, as is the case with the rings of the thorax, but the front one overlaps the hind ones, and these can be retracted one into the other like the joints of a telescope. The muscles running from one ring to another, which retract the hinder joints into those before them, are so elastic, and they originate so far forward in the front segment, that the whole abdomen may often be at one time twice as long as at another. This looseness in the jointing is not only found to be very useful to the insect as a means to enable it to bend that part of the body, and so apply the tail organs as the insect requires, but also it allows the internal organs to be distended without inconvenience; and in many of the most active insects a rhythmical breathing is observed, caused by the shortening and elongating of this part of the body.

The food-canal of insects is usually not very long or very complex. From the mouth a narrow tube runs right through to the abdomen, thus interfering as little as possible with the play of the muscles of that part. When it has arrived at that division of the body, it enlarges into a bulb or crop, which is sometimes, as in bees, an enlargement lying in the track of the canal, and sometimes a bag or reservoir connected with the throat by a narrow duct which enters sideways into the canal. Below this, or occupying its place when it is absent, a gizzard is often found, whose horny internal longitudinal ridges grind the food. Below this is the true stomach—a long sac with transverse wrinkles, in the folds of which secreting glands are found. At the lower end of this a number of long tubes enter. Six of these are seen in the beetle in Fig. 30, and in the bee there are a large number. These long tubes, which lie in the body cavity tangled and twisted among the other organs, commence in blind ends—they are known as the *Malpighian vessels*, and their office is the removal of waste nitrogenous matter from the body. Below the entrance of these vessels, the alimentary canal contracts, and has been called the small intestine. At the end of this is a valve which prevents an entrance of matter from behind. Beyond the valve is the large intestine, which sometimes dilates into a chamber into which the reproductive products and the poison from the poison-bag, where it exists, empty themselves. The orifice of exit is always at the extreme end of the animal. It should have been mentioned that into the mouth of the œsophagus two or more salivary glands usually empty themselves. These are often more or less attached to the sides of the canal, but are sometimes free. Sometimes the liquid secreted by these is very pungent and irritating, though why it should be so it is difficult to conjecture, unless, by being poured into the wound made by the compound lancet, it causes a flow of blood to that part. Otherwise, one would have supposed that the irritation caused would have been equally disturbing to the drinking insect and the victim of its attack.

One of the greatest peculiarities of insects—though, as we have seen, the apparatus is not confined to them—is the *tracheal* system. In insects the necessary process of the aëration of the blood is not accomplished through a soft membranous skin, for this in them is hard and dry; nor by protrusions of the circulatory system, so as to expose the contained blood to the influence of the surrounding medium; nor even by setting apart some internal cavity for the process; but the air is introduced and sent by small dividing and subdividing vessels into every organ of the body, and so the function of respiration is diffused through all parts. The entrance of the air to the body is not through the mouth, as in vertebrate animals, but through a number of oval holes in the sides of the body. As a rule, it may be said that there are a pair of these to each segment of the body, but they

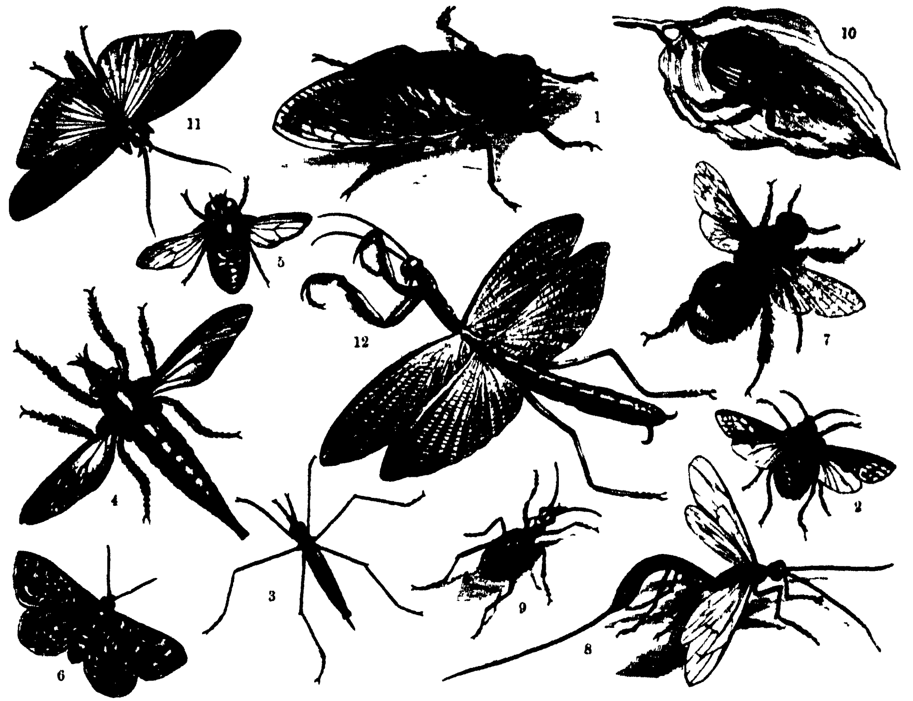


Fig. 31.—Hemiptera:—1, Cicada (an Homopterous Insect); 2, Halys; 3, Hydrometra. Diptera:—4, Asilus Crabroniformis; 5, Eristalis. Lepidoptera:—6, Euclidia Mi. Hymenoptera:—7, Apathus; 8, An Ichneumon Fly. Coleoptera:—9, Cicindela; 10, Geotrupes. Neuroptera:—11, Phryganea. Orthoptera:—12, Mantis Religiosa.

are by no means always present in every segment. These oval holes are called spiracles, or breathing pores. They are well seen in the illustrations of the caterpillar and chrysalis of the privet hawk-moth (Fig. 30).

In the sketch of the tracheal system of a species of parasite given in the picture (Fig. 30), it will be seen that each spiracle has a little globular enlargement below it, and that canals lead from these to join a large lateral canal which runs down the side of the body, uniting with its fellow both before and behind. From certain parts of this similar vessels are given off which run to the more important parts of the body, and there break up into branches. In this creature the tracheal system is of the simplest kind, but in the generality of insects it is very complex, the two lateral canals sending off cross branches, while from all parts of the main canals branches spring, and by dividing and subdividing, run into all the organs, so that no small portion of the viscera, whether taken from the nervous or any other system, can be examined under a microscope without revealing some of these vessels.

It may be asked, how can these minute vessels be distinguished from others when under a microscope? This is easily done on account of the peculiarity of their structure. Each tube consists of two thin membranes, with a spiral thread lying between them. The membranes are transparent, and the closely coiled thread within them looks like the wire spring of a bell. The use of these spiral threads is manifest. The air tubes must be kept open in order that respiration may be carried on, and yet the movement of the body, or any pressure, is liable to close them. These elastic coils, therefore, maintain the tube, and by their resiliency open it when it has been closed by pressure.

The nervous system is quite after the type of all Articulates, which we have described elsewhere in these lessons.

One of the most striking and interesting of phenomena in nature is the transformation at certain stages of the development of insects. Such transformations are not confined to this class, but they were first noted in it, and are better defined and studied in insects than in any other class. Most animals have a protective epidermis, which, being extra-vascular, is dead or dying. Some have this constantly wearing off, while others retain it for a time, and slough it off at one act. Many creatures also, during growth, go through considerable change in the proportion and structure of these parts. Now in insects, since the whole form of the animal is dependent on the external integument, and the whole of this is thrown off together, while at the same time extreme changes have gone on in the internal structure, we have, as a result, periodical changes of so radical a character that they are called metamorphoses. These changes are, however, very different in different insects. In all there is a growing state, in which they eat enormously. This state is called the *larva*. Then there is a state of change, in which the forms of the organs of the perfect insect are being developed: *e.g.*, the wings grow, and the body is transformed into a shape convenient for flight. This is called the *pupa* state. Lastly, there is the perfect state, in which the insect never grows or changes, and in which its most serious business seems to be the reproduction of its kind. In this state it is called the *imago*.

The main modifications in the method of metamorphosis consist in the condition of the insect in the second or pupa state. In butterflies and flies, it has no mouth nor organs of locomotion, and is invested in a coffin-like box, so that its external appearance is quite unlike that of the perfect insect. In bees and beetles the pupa has already taken on the form of the perfect insect, and the limbs are detached from the body, but it is quite quiescent, while in grasshoppers and plant-bugs the three states are much alike. The only thing which distinguishes the different states of these latter from one another is the growth of the wings during the pupa state. In Fig. 30 the three states of a sphinx-moth, called the privet hawk-moth, are represented. The larva, or caterpillar, is holding its head aloft after its peculiar manner, from which habit it derived the name of sphinx. On the left hand there is a representation of two cells, one of which contains a wasp larva, which is fed in its cell by the workers. Another cell contains a pupa wasp, which is sealed up to protect it while it no longer eats. On the side a perfect insect is represented as climbing up the comb.

We now propose to give some account of the classification of insects.

Entomology, or the study of insects, has always been a favourite branch of natural history. The great beauty, both of form and colouring, to be found in many of the species of this class has always commended it to the attention of all who have any bent towards such studies. Probably the hues of the gorgeously tinted butterfly, or the elegance and graceful activity of the dragon-fly, have for many a youth been the first incitement to the study of living creatures. Besides these, many thousands who have no claim to be called naturalists have found great pleasure in collecting and preserving insects. "A thing of beauty is a joy for ever," and whether the external stamp of excellence called beauty induces men to examine and appreciate the other excellences of Nature or not, it is good that the great God should receive the praise of a thousand joyous hearts for this alone. The collection and study of insects is pursued with greater ease than that of any other class. Found everywhere in almost infinite variety, they offer an unlimited field in which every lover of Nature can occupy himself. Their size, ranging as it does between a very few inches in length down to a remarkable minuteness, enables them to be stored, notwithstanding their great multitude, in a space which is at the command of everyone. All these facilities for the collection and study of insects would, however, be nugatory if it were not for the peculiarities of their structure. As we have seen already, the great peculiarity and excellence of insects is the perfection of the organs of *relation*, as they are called. By *organs of relation* is meant the organs through which the animal acts upon, or is brought into contact with, the outer world, such as organs of sense, locomotion, and prehension, of attack and defence. Hence Nature seems, in the case of insects, to have expended her most exquisite workmanship in the architecture of their superficies, or the boundary between themselves and the outer world. The character, the capabilities, and the efficiency of insects depend mainly on the framework of their external casing. This external casing is the resisting and supporting structure upon which all the soft parts are built. From this peculiarity of structure it follows that when an insect is dried—when the muscles have withered and its nervous, nutritive, and reproductive organs have shrivelled or decayed—since they are all internal, not only is its beauty left intact, but many of the essential features by which its habits and relationships may be determined are undestroyed. A class which can be studied with any degree of completeness without recourse to the difficult process of dissection is sure to receive attention. A simple lens, or at most a microscope of low power, directed upon the exterior of a set specimen, is quite sufficient to determine not only its place in all existing classifications, but even to furnish all the information on which the reasons for the adoption of the several systems of classifications are based. Nevertheless, though all that has been stated is true, though the museums of Europe contain vast collections gathered from all parts of the earth, though the class itself is so rich in species that in it, if anywhere, we might hope to find a complete series which would throw light on the general principles of classification—yet the arrangement of insects into minor groups is by no means placed on a satisfactory footing. The external parts of insects have been examined with a minuteness and described with a care which strikes the uninitiated with wonder. Not only the shape of all the plates composing the rings of the body, and the number and form of the joints of the legs and antennæ, have been made to yield characters for classification, but even the number and shape of the joints of the appendages of the mouth-organs, and the direction and number of the nervures of the wings, together with the shape of the "cells" which they circumscribe, have been impressed into the service of taxonomy. Yet naturalists are far from agreeing in the arrangement of insects into their larger groups. Some classifiers place all insects under seven groups or orders, and some are not contented with less than double that number. Concerning the more conspicuous and independent insects there seems to be a considerable agreement as to classification, and these are comprised under seven orders. The additional orders of those who make more orders than seven are made of minute and generally parasitic insects. These, owing to the peculiarity of their method of life, constitute what may be called *aberrant* groups—that is, groups which depart considerably from the ordinary typical forms of insects. This idea of aberrant forms will become clearer when we come to describe the several orders. These aberrant groups of insects have been constituted into new orders, or included under the older and better established orders of the more conspicuous insects, according as each classifier is more prone to dwell on the differences or the resemblances of animal forms.

Without going into the merits of the several systems, we shall adhere to that classification by which all insects are arranged into seven orders, because this system will probably give to the reader a clearer idea of the different groups of insects than the ampler system. We have therefore to distribute the aberrant groups among these seven orders, but in so doing we shall call attention to them, so that the reader may not be perplexed when he refers to other systems of classification.

The class Insecta is well defined by the following characters. They are animals with well-developed jointed limbs, one pair of antennæ or head-feelers, compound eyes, palpless mandibles, a distinct head, a trisegmented thorax, to which are attached three pairs of legs, and (normally) two pairs of wings, limbless abdomen, and respiration by tracheæ.

The terms used in this classification will be understood by those who have read the last lesson. The whole definition is necessary in order to cut off the insects from all the neighbouring classes. Thus they possess jointed limbs in common with centipedes, spiders, and crustaceans, but they are by this character cut off from the worms. Centipedes (*Myriopoda*) have one pair of antennæ, as insects have, but this peculiarity severs these classes from the spiders, which have no antennæ, and also from the crustaceans, which have two pairs. On the other hand, the absence of limbs on the last division of the body, while it is likewise characteristic of the spiders, completely separates them from the myriopods and crustaceans. The possession of two pairs of wings is peculiar to insects, but still this is not a good distinctive character, because wings are not found in all insects.

Insects as thus defined may be divided into the following orders, to each of which we affix the ordinal definition :—

1. *Hemiptera* (half-winged).—Insects with imperfect metamorphosis, free prothorax, and suctorial mouths.
2. *Diptera* (two-winged).—Insects with perfect metamorphosis, suctorial mouths, membranous naked fore wings, and aborted hind wings.
3. *Lepidoptera* (scale-winged). — Insects with perfect metamorphosis, suctorial mouth organs, and membranous fore and hind wings, covered with close-set scales.
4. *Hymenoptera* (membrane-winged). — Insects with perfect metamorphosis, biting jaws, small ring-shaped prothorax, firmly fastened by its upper part to the succeeding segment, and membranous fore and hind wings, of which the latter are the smaller.
5. *Coleoptera* (sheath-winged). — Insects with perfect metamorphosis, biting jaws, free, strongly developed prothorax, and hard horny fore wings (elytra).
6. *Neuroptera* (net-winged). Insects with perfect metamorphosis, biting jaws, free prothorax, and membranous fore and hind wings.
7. *Orthoptera* (straight-winged).—Insects without or with imperfect metamorphosis, biting jaws, and the first segment of the thorax united to the second.

GERMAN.—XLI.

[Continued from p. 257.]

EXAMPLES ILLUSTRATING THE VARIOUS USES OF THE PREPOSITIONS *(continued).*

Nach.

Der Vater reiſt nach Ame'rika.	The father is going to America.
Der Ritter greiſt nach ſeinem Schwerte.	The knight grasps (after) his sword.
Die armen Waiſen ſchreien nach Brod.	The poor orphans cry for bread.
Umſonſt' ſpäh' ich nach einem Auge, das empfin'det. (Schiller.)	In vain I look for an eye that feels.
Laßt uns tagen nach den alten Bräuchen des Landes. (Schiller.)	Let us meet according to the ancient customs of the land.
Thu, was vor dir kein Weib gethan', nach dir kein Weib mehr thun wird. (Schiller.)	Do what before thee no woman has done, after thee no woman will do again.

Seit.

Seit der Ankunft ſeines Vaters ſcheint er zufrie'den zu ſein.	Since the arrival of his father he appears to be contented.
Er iſt ſeit einer Woche hier.	He has been here a week.
Seit Men'ſchengedenken iſt kein ſolches Mißjahr gewe'ſen.	There has not been such a sterile year within the memory of man.
Seit geſtern habe ich ihn nicht geſe'hen.	Since yesterday I have not seen him.

Über.

Der Faule ſtirbt über ſeinen Wünſchen.	The sluggard dies over his wishes.
Das geht über meinen Verſtand'.	That goes beyond my comprehension.
Sie ſind ſchon über ein Jahr hier.	You have been here already more than a year.
Er erhält' Brief über Brief.	He receives letter upon letter.
Sie zog den Schleier über das Geſicht'.	She drew the veil over her face.
Er war über dieſe Antwort ganz entrüſt'et.	He was perfectly indignant at this reply.
Er hat über dieſen Punkt noch nicht entſchie'den.	He has not yet decided concerning this point.
Cook's Beglei'ter ſchweigen von den Minera'lien Neuhol'lands, und ſcheinen über den Reizen der dor'tigen Flora vergeſ'ſen zu haben, daß auch der Boden, über den ſie hin'eilten, die Blicke des Kenners verdie'nte. (G. Forſter.)	Cook's companions are silent respecting the minerals of New Holland, and appear, amidst the charms of the flora of that country, to have forgotten that the soil over which they hurried was likewise deserving of the scrutiny of the philosopher.
Laß den Herbſt in ſchwarzen Wettern hoch über unſerm Haupte ziehn.	Let the autumn in dark storms sweep high above our heads.

Um.

Um ſein Leben zu retten, verrieth' er ſeinen Freund.	In order to save his life, he betrayed his friend.
Die Ritter ſetzten ſich um den runden Tiſch.	The knights seated themselves about the round table.
Der Sieger hatte einen Kranz um das Haupt.	The victor had a wreath around his head.
Der Feind la'gerte ſich um die Stadt herum'.	The enemy encamped (himself) around the city.
Sie rennen um die Wette.	They run for a wager.
Was thut man nicht um Geld?	What does one not do for money?
Es dreht ſich Alles um mich.	Everything turns about me.
Er iſt um halb zwei angekommen.	He arrived at half-past one.
Man hat ihn um ſein Vermö'gen (um ſein Geld) gebracht'.	They have deprived him of his property.
Es muß um einen Zoll länger ſein.	It must be an inch longer.
Sie kümmern ſich mehr um den Krug, als um den Krieg. (Schiller.)	They concern themselves more about the wine than the war.

Unter.

Die Soldaten ſtehen unter Waffen.	The soldiers are under arms.
Das ganze Land ſteht unter Waſſer.	The whole land is under water.
Es iſt unter ſeiner Würde, ſo zu handeln.	It is beneath his dignity so to act.
Er iſt unter einem andern Namen zu uns gekom'men.	He came to us under another name.
Iſt keiner unter uns, der dieſe Schmach räche?	Is there no one among us who may avenge this outrage?
Es iſt unter uns kein Geheim'niß.	There is no secret among us.

Vor.

Sie führten ihn vor den Richter.	They brought him before the judge.
Der Frühling iſt vor der Thür.	The spring is at the door.

Ich will mich nicht vor dir verber'gen.	I will not conceal myself from thee.
Vor ihr habe ich keine Geheim'niſſe.	Before her I have no secrets.
Er iſt ganz außer ſich vor Zorn.	He is perfectly beside himself with rage.
Das Schiff liegt vor Anker.	The ship is lying at anchor.
Er iſt vor drei Wochen an'gekommen.	He arrived three weeks ago.
Er hat ihn vor den Kopf geſchoſ'ſen.	He has shot him in the head.

Zu.

Er reiſt zu Lande, und ich zu Waſſer.	He travels by land, and I by water.
Er liegt noch zu Bette.	He is still lying in bed.
Ich ſtehe Ihnen zur Seite.	I (will) stand at your side (*i.e.*, to aid).
Ich möchte dieſen Mann nicht zum Nachbar haben.	I should not like to have this man as a neighbour.
Er nimmt meinen Rock zum Muſter.	He takes my coat as a pattern.
Kommen Sie morgen zu meinem Vater; Sie können die Sache mit ihm beſpra'chen.	Come to my father to-morrow; you may talk the matter over with him.
Wir haben Abraham zum Vater.	We have Abraham to our father.
Gehen Sie doch zu meinem Bruder	Pray go to my brother.
Deines Grames Zeugen werden auf zum Himmel gehn. (Bürger)	The witnesses of thy grief will rise to heaven.

THE CONJUNCTIONS.

Conjunctions are words used in connecting sentences. As, however, there are various *kinds* of connections existing among sentences, it has been customary to classify the conjunctions according to the nature of the connection which they are employed to indicate. Hence we have (among other classes) the following:—

Copulatives: as, und, and; auch, also.
Disjunctives: as, entweder, either; oder, or.
Adversatives: as, aber, but, however; allein, but; doch, yet.
Negatives: as, weder, neither; noch, nor.
Comparatives: as, wie, as; ſo, so, thus; als, than; gleichwie, just as.
Conditionals: as, wenn, if; falls, in case that; wofern, provided that.
Causals: as, denn, for; weil, since, because.
Conclusives: as, darum, therefore; daher, hence; deßhalb, therefore.
Concessives: as, obwohl, obſchon, obgleich, wenn, although.
Finals: as, daß, that; auf daß *and* damit, in order that; um zu, in order to.

We give below a list of the conjunctions that most commonly occur in German, premising only that some of the words here set down as conjunctions are also employed as adverbs; for it will of course be kept in mind that the *office* performed by a word determines its name and character.

Aber, but.
Allein, but.
Als, as, than, when.
Alſo, so then, consequently.
Auch, also, *ever*.
Auf daß, in order that
Bis, until.
Da, since.
Daher, therefore, hence.
Dafern, in case that, if.
Daß, that, in order that.
Damit, in order that
Darum, therefore, on that account.
Denn, for, because, than.
Dennoch, still, nevertheless.
Deßhalb, therefore, on that account.
Deſto, the.
Doch, yet, however, still.
Ehe, before that, ere.
Entweder, either.
Falls, in case that.
Folglich, consequently.
Je — deſto, the — the.
Jedoch, yet, nevertheless.
Indem, while, because, since.
Mithin, consequently.
Nachdem, after that.
Noch, nor, nor yet.
Nun, therefore, then.
Nur, but, only.
Ob, whether, if.
Obgleich, though, although.
Obſchon, though, although.
Obwohl, though, although.
Oder, or.
Ohne, without, except.
Ohngeachtet, notwithstanding.
So, thus, therefore, if.
Sondern, but.
Und, and.
Ungeachtet, notwithstanding.
Während, whilst.
Während dem, whilst.
Während daß, whilst, than.
Weder, neither.
Wenn, if, as.
Weil, because.
Wenngleich, although.
Wennſchon, although.
Wie, as, when.
Wiewohl, though.
Wo, if.
Wofern, if, in case that.

INTERJECTIONS.

Interjections, as the name implies, are commonly *thrown into* a sentence, without, however, changing either its structure or its signification. They are merely the signs of strong or sudden emotion, and may be classified according to the *nature* of the emotion which they indicate: some expressing *joy*, some *sorrow*, some *surprise*, and so on. The list below contains those only that most commonly occur:—

Ach! alas!
Ah! ah!
Ei! eigh!
Ha! ha!
He! ho!
He da! ho there!
Halt! hold! stop!
Holla! holla!
Huſch! quick! hush!
Leider! alas!

Oh! o!	oh! O!	Heiſa!	hurrah!	Hui!	hoa! quick!
Pfui!	fy!	Juchheiſa!	huzzah!	Sieh!	lo!
Pſt!	hist!	Wohlan!	well then!	Hum!	hem!
Wehe!	wo! alas!				

It may be added that other parts of speech, and even whole phrases, are often employed as interjections, and in parsing are treated as such.

BRIEF NOTES ON SYNTAX.

Syntax is that part of grammar which explains the relations and offices of words as arranged and combined in *sentences*.

The essential parts of every sentence are the *subject*, which is that of which something is affirmed; and the *predicate*, which is that which contains the affirmation.

The subject is either a noun or that which is the representative or equivalent of a noun; the predicate is either a verb alone, or a verb in conjunction with some other part or parts of speech. All the words entering into a sentence are to be regarded as mere *adjuncts*. The following sentences exhibit the subject and the predicate under several varieties of form:—

Subject.		*Predicate.*
God		exists.
Man	is	mortal.
Throwing the stone	was	his crime.

In the sentence *God exists*, the verb *exists* is the predicate, affirming as it does the existence of the Almighty. But in the sentence *Man is mortal*, *mortality* is what is affirmed of man, and the verb (*is*) is the mere link that connects the subject and the predicate together. It is thence called the *copula*.

Sentences are either *simple* (*i.e.*, contain a single assertion or proposition) or *compound* (*i.e.*, contain two or more assertions or propositions). Of the various parts of a sentence, whether principal or adjunct, we come now to speak more in detail, so as to show the relation, agreement, government, and arrangement of words in construction.

THE ARTICLES.

Rule.—The article in German, whether definite or indefinite, is generally employed wherever the corresponding article would be used in English.

OBSERVATIONS.—This rule is, of course, founded upon the presumption that the student is familiar with the usage of the *English* in respect to the article. In the specifications that follow, therefore, he is to look only for the points in which the German *differs* from the usage of our own language.

(1) The Germans insert the *definite* article—

(*a*) Before words of *abstract* or *universal* signification, as:—Der Menſch iſt ſterblich, man (*i.e.*, *every* man) is mortal; das Gold iſt dehnbar, gold is ductile; das Leben iſt kurz, life is short; die Tugend führt zum Glücke, virtue leads to happiness.

(*b*) Before the names of certain divisions or periods of time, as:—Der Sonntag, Sunday; der Montag, Monday; der Dezember, December; der Auguſt, August; der Sommer, summer.

(*c*) Before certain names (*feminines*) of countries, as:—Die Türkei, Turkey; die Schweiz, Switzerland; die Lombardei, Lombardy.

(*d*) Before the names of authors, when used to denote their works, as:—Ich leſe den Leſſing, I am reading Lessing.

(*e*) Before the proper names or titles of persons, when used in a way denoting familiarity or inferiority, as:—Grüße die Marie, greet (or remember me to) Mary; ſagte dem Luther, daß ich ihn zu ſehen wünſche, tell Luther that I wish to see him. Also when connected with *attributive* adjectives, as:—Die kleine Sophie, little Sophia.

(*f*) Before words (especially proper names of persons) whose cases are not made known either by a change of termination or by the presence of a preposition, as:—Das Leben der Fürſten, the life of princes; die Frau des Sokrates, the wife of Socrates; der Tag der Rache, the day of (the) vengeance.

(*g*) Before the names of ranks, bodies, or systems of doctrine, as:—Das Parlament, Parliament; die Regierung, government; die Monarchie, monarchy; das Chriſtenthum, Christianity. Also in such phrases as, In der Stadt, in town; in der Kirche, at church; die meiſten Menſchen, most men.

(*h*) Before the words (signifying) *half* and *both*, as:—Die halbe (*not* halbe die) Zahl, *half* the number; die beiden (*not* beide die) Brüder, *both* the brothers.

(*i*) Before words denoting the *limit* within which certain specified numbers or amounts are confined, wherein in English the *indefinite* article would be used, as:—Zweimal die Woche, twice *a* week.

(*k*) Before a past participle joined with a noun, which in English *precedes* the participle, as:—Das verlorene Paradies (*lit.* the lost Paradise), Paradise Lost.

(2) *Note*, further, that the German differs from the English in *omitting* the definite article—

(*a*) Before certain law appellatives, as:—Beklagter, (*the*) defendant; Kläger, (*the*) plaintiff; Appellant, (*the*) appellant; Supplicant, (*the*) petitioner.

(*b*) Before certain common expressions, such as In beſter Ordnung, in (*the*) best order; Überbringer dieſes, (*the*) bearer of this; and certain adjectives and participles treated as nouns, as:—Erſterer, (*the*) former; letzterer, (*the*) latter; beſagter, (*the*) beforesaid (person).

(*c*) Before certain proper names of places, as:—Oſtindien, (*the*) East Indies; Weſtindien, (*the*) West Indies; and before the names of the cardinal points, as:—Oſten, (*the*) east; Weſten, (*the*) west; Süden, (*the*) south; Norden, (*the*) north.

(3) *Note*, again, that the Germans, in using certain collective terms preceded by adjectives, employ the *indefinite* article where the English would use the definite, as:—Ein hochweiſer Rath, the (lit. *a*) most learned Senate; eine löbliche Univerſität, the (*an*) honourable University.

(4) In German, also, the indefinite article stands *before* (not *after*, as in English) the words *such*, *half*, thus:—Ein ſolcher Mann (*not* ſolcher ein Mann), such *a* man; ein halbes Jahr (*not* halbes ein Jahr), half *a* year. In questions, direct or indirect, like the following, Einen wie langen Spazierritt hat er gemacht? how long a ride has he taken? it must be noticed that the article stands *before* wie: thus, Einen wie langen (a how long), and not, as in English, *how long a*.

(5) The German differs again from the English in not using an article at all in the phrases answering to the English: *a* few; *a* thousand; *a* hundred.

THE NOUN.

Rule.—A noun or pronoun which is the *subject* of a sentence must be in the nominative case, as:—Der Menſch denkt, Gott lenkt, man proposes, God disposes.

OBSERVATIONS.—The subject or nominative in German is seldom omitted, except in the case of the pronouns agreeing with verbs in the second person (singular and plural) of the imperative, as:—Lies (du), read! Geht und ſagt (Ihr) ihm, go and tell him.

Rule.—A noun or pronoun which is the *predicate* of the sentence must be in the nominative case, as:—Er war ein großer König, he was a great king; dieſer Knabe iſt Kaufmann geworden, this boy has become a merchant.

Rule.—A noun used to limit the application of another noun signifying a different thing is put in the genitive, as:—Der Lauf der Sonne, the course of the sun; die Erziehung der Kinder, the education of the children.

OBSERVATIONS.—(1) If, however, the *limiting* noun (unless restricted itself by an adjective or some other qualifying word) signify *measure*, *number*, *weight*, or *quantity*, it is then put in the same case with that which it limits, as:—Sechs Pfund Thee (*not* Thees), six pounds (of) tea; but (with a restrictive term), Sechs Pfund dieſes Thees.

(2) It should be observed that the two nouns under this rule must be of *different* significations; for two nouns standing for the *same* thing would be in the same case, forming an instance of *apposition*.

(3) The noun in the genitive—that is, the *limiting* noun—is commonly said to be *governed* by the other one.

(4) It seems hardly necessary to observe that under this rule come all words which perform the *office* of nouns—as pronouns, adjectives used substantively, etc.; thus, Die Gnade der Großen, the favour of the great.

(5) We may say in English, "he is a friend *to*, or an enemy *to*, or a nephew *to* anyone," where, were these phrases put into German, we might expect the *dative* to be used. But in such cases the German always employs the genitive: thus, Er iſt ein Feind ſeines Vaterlandes, he is an enemy *of* his native country.

(6) We say in English, "the month *of* August," "the city *of* London," and the like, where the common and the proper name of the same thing are connected by the preposition *of*. The Germans put the two nouns in *apposition*: thus, Die Stadt London.

(7) So, too, in English we say, "the fifth *of* August," but in German the numeral is put in direct agreement with the name of the month, as:—Der fünfte Auguſt, the fifth *of* August, *or* August the fifth.

(8) In place of the genitive, the preposition von, followed by the dative, is in the following instances generally used:—

(*a*) When succeeded by nouns signifying quality, rank, measure, weight, age, distance, and the like, as:—Ein Mann von hohem Stande, a man of high standing; ein Schiff von zwei hundert Tonnen, a ship of two hundred tons; ein Mann von achtzig Jahren, a man of eighty years; eine Reiſe von drei Meilen, a journey of three miles; etc.

(*b*) When followed by nouns denoting the material or substance of which anything is made, as:—Ein Becher von Silber, a cup of silver (*i.e.*, a silver cup); eine Uhr von Gold, a gold watch; etc.

(*c*) When followed by nouns whose cases are not indicated by the terminations of declension or by the presence of the article, as:—Ein Vater von ſechs Kindern, a father of six children; die Königin von England, the Queen of England; die Grenzen von Frankreich, the boundaries of France.

(*d*) When followed by a word indicating the *whole*, of which the word preceding expresses but a *part*, as:—Einer von meinen Bekannten, one of my acquaintances; welcher von beiden? which of the two?

Rule.—A noun limiting the application of an adjective, where in English the relation would be expressed by such words as *of* or *from*, is put in the genitive, as:—Die meiſten Verluſte ſind eines Erſatzes fähig, most losses are capable of reparation; die Erde iſt voll der Güte des Herrn, the earth is full of the goodness of the Lord.

OBSERVATIONS.—(1) The adjectives comprehended under this rule are, among others, the following:—

Bedürftig,	in want, needing.	Gewöhnt,	used to, in the habit.
Bewußt,	conscious.	Kundig,	having a knowledge, skilled.
Fähig,	capable, susceptible.	Ledig,	empty, void.
Froh,	glad.	Müde,	tired, weary.
Gewahr,	aware.	Schuldig,	guilty, indebted.
Gewärtig,	waiting, in expectation.	Theilhaft,	partaking.
Gewiß,	sure, certain.	Werth,	worth, worthy.

(2) After gewahr, gewohnt, los, müde, ſatt, voll, and werth, the *accusative* is often used, as:—Er ward ſeinen Bruder gewahr, he was aware of (the presence of) his brother—*i.e.*, he observed his brother.

Rule.—A noun limiting the application of any of the verbs following is put in the genitive:—

Achten,	to mind *or* regard.	Harren,	to wait.
Bedürfen,	to want.	Lachen,	to laugh.
Begehren,	to desire.	Pflegen,	to foster.
Brauchen,	to use.	Schonen,	to spare.
Entbehren,	to need.	Spotten,	to mock.
Ermangeln,	to want *or* be without.	Verfehlen,	to miss *or* fail.
Erwähnen,	to mention.	Vergeſſen,	to forget.
Gedenken,	to think *or* ponder.	Wahren,	to guard.
Genießen,	to enjoy.	Wahrnehmen,	to observe.
Gewahren,	to observe.	Walten,	to manage.
		Warten,	to attend to *or* mind.

OBSERVATIONS.—Bedürfen, begehren, brauchen, entbehren, erwähnen, genießen, pflegen, ſchonen, verfehlen, vergeſſen, wahrnehmen, wahren, and warten, take more frequently, in common conversation, the *accusative*. Achten, harren, and warten are more commonly construed with auf, and lachen, ſpotten, and walten with über, before an *accusative*.

Rule.—The following *reflective* verbs take, in addition to the pronouns peculiar to them, a word of limitation in the genitive:—

Sich annehmen,	to engage in.	Sich entbrechen,	to forbear.
„ bedienen,	to use.	„ enthalten,	to refrain.
„ befleißen, „ befleißigen,	to apply to.	„ entſchlagen,	to get rid of.
„ bemächtigen,	to take possession.	„ entſinnen,	to recollect.
„ bemeiſtern,	to seize.	„ erbarmen,	to pity.
„ entäußern,	to abstain.	„ erfrechen,	to presume.
„ entblöden,	to dare, to be bold.	„ erinnern,	to remember.
		„ erkühnen,	to venture.
		„ erwehren,	to resist.
		„ erfreuen,	to rejoice.
Sich getröſten,	to hope for.	Sich unterfangen,	to undertake.
„ rühmen,	to boast.	„ verſehen,	to be aware.
„ ſchämen,	to be ashamed.	„ wehren,	to resist.
„ überheben,	to be haughty.	„ weigern,	to refuse; etc. etc.

OBSERVATIONS.—The genitive is in like manner put after the following *impersonals*:—

Es gelüſtet mich, I desire.
Es jammert mich, I pity *or* compassionate.
Es reut mich, I repent *or* regret.
Es lohnt ſich, it is worth while.

Rule.—The following verbs require after them a genitive denoting a *thing* and an accusative signifying a *person*:—

Anklagen,	to accuse.	Entſetzen,	to displace.
Belehren,	to inform.	Überheben,	to exempt.
Berauben,	to rob.	Überzeugen,	to convince.
Beſchuldigen,	to accuse.	Verſichern,	to assure; etc.

OBSERVATIONS.—The verbs above, when in the *passive* voice, take for their *nominative* the word denoting the person, the genitive of the *thing* remaining the same, as:—Er iſt eines Verbrechens angeklagt worden, he has been accused of a crime.

Rule.—Nouns denoting the *time*, *place*, *manner*, *intent*, or *cause* of an action, are often put absolutely in the genitive, and treated as adverbs, as:—Des Morgens gehe ich aus, in the morning I go out; man ſucht ihn aller Orten, they seek him everywhere; ich bin Willens hinzugehen, I am willing to go there.

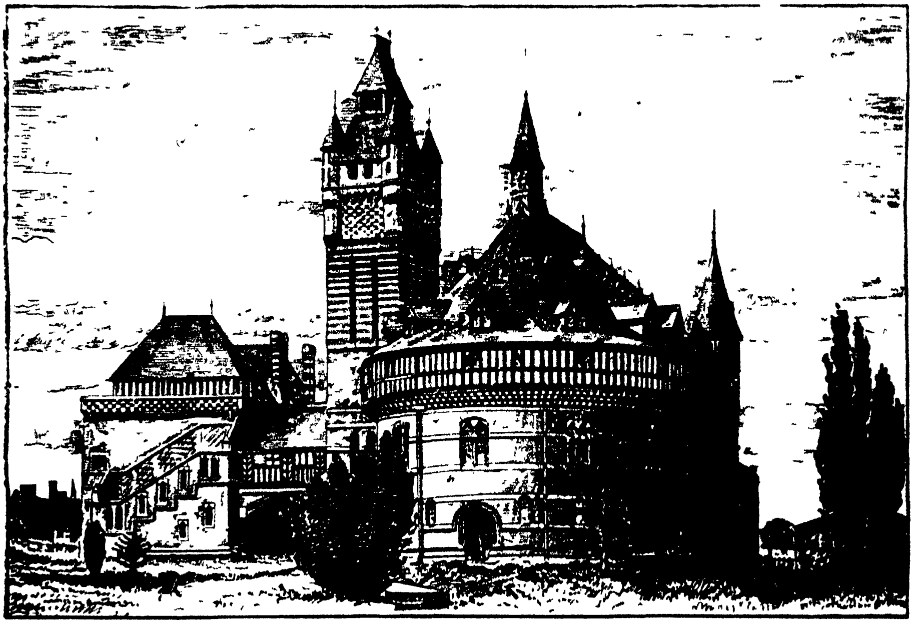
OBSERVATIONS.—This adverbial use of the genitive is quite common in German. In order, however, to express the particular *point*, or the *duration* of time, the accusative is generally employed, or a preposition with its proper case.

Rule.—A noun or pronoun used to represent the object in *reference* to which an action is done or directed is put in the dative, as:—Ich danke dir, I thank (*or* am thankful *to*) you; er iſt dem Tode entgangen, he has escaped from death.

OBSERVATIONS.—(1) The dative is the case employed to denote the person or the thing *in relation to* which the subject of the verb is represented as acting. Compared with the accusative, it is the case of the *remote* object, the accusative being the case of the *immediate* object. Thus, in the example, Ich ſchrieb meinem Vater einen Brief, I wrote (to) my father a letter, the immediate object is *a letter;* while *father*, the person *to whom* I wrote, is the remote object. The number of verbs thus taking the accusative with the dative is quite large.

(2) On the principle explained in the preceding observation may be resolved such cases as the following:—Es thut mir leid, it causes me sorrow *or* I

am sorry; es wird mir im Herzen weh thun, it will cause pain to me in the heart (it will pain me to the heart), etc.



The Shakespeare Memorial Theatre, Stratford-on-Avon.

(3) A right regard to the observation made above—namely, that the dative merely marks that person or thing in *reference to* which an action is performed—will serve also to explain all such examples as these:—Ihnen bedeutet dieſes Opfer nichts, to you (*i.e.*, so far as you are concerned) this sacrifice means nothing; die Thränen, die Eurem Streit gefloſſen, the tears which have flowed in relation to (*i.e.*, from) your dispute; mir tödtete ein Schuß das Pferd, a shot killed a horse for me (*i.e.*, killed my horse).

(4) The rule comprehends all such verbs as the following:—Antworten, to answer; danken, to thank; dienen, to serve; drohen, to threaten; fehlen, to fall short; fluchen, to curse; folgen, to follow; fröhnen, to do homage; gebühren, to be due; gefallen, to please; gehören, to pertain to; gehorchen, to obey; genugen, to satisfy; gereichen, to be adequate; gleichen, to resemble; helfen, to help; etc.

(5) This rule also comprehends all reflective verbs that govern the dative, as:—Ich maße mir keinen Titel an, welchen ich nicht habe, I claim to myself no title which I have not. As also all impersonals requiring the dative, as:—Es beliebt mir, it pleases me, *or* I am pleased; es mangelt mir, it is wanting to me, *or* I am wanting; etc.

(6) The dative is also often used after passive verbs, as:—Von Geiſtern wird der Weg dazu beſchützt, the way thereto is guarded by angels; ihm wird gelohnt, *lit.* it is rewarded to him—*i.e.*, he is rewarded.

ENGLISH LITERATURE.—XI.

[*Continued from p.* 261.]

THE ELIZABETHAN PERIOD: SHAKESPEARE (*continued*).

THE COMEDIES.

Among his contemporaries there is every reason to believe that Shakespeare's comedies were at least as highly appreciated as his tragedies. Certainly, a very few years afterwards, Milton considered the plays of Shakespeare fit entertainment not for the pensive and serious man, whom he depicts in "Il Penseroso," but for the cheerful and light-hearted man, who is portrayed in "L'Allegro." It is in the latter mood that he would hear

"Sweetest Shakespeare, Fancy's child,
Warble his native wood-notes wild."

The comedies of Shakespeare naturally divide themselves into several classes, though of course any such division must be a mere approximation to the truth. The first and most numerous class includes a series of plays which are rather comedies of incident than of character. The scene of these plays is almost always laid in foreign countries, and thus the effect of commonplaceness on the one hand, and the reproach of improbability on the other, is avoided. They show little study of character, and little or nothing of that effort to work out the deeper problems of human nature, or deal with the subtler enigmas of life, which is so distinctively the characteristic of another class of Shakespeare's plays. Even the plot of these plays has not always much more probability than the characters have of individuality. Their charm is rather in the incidents of the voyage than in the end to which it leads or the characters of the travellers. Variety of incident, a perpetual succession of pleasurable pictures, dialogue whose freshness never fails, poetical beauty of language, an incessant sparkle of wit, and unflagging powers of humour—these are the chief sources of pleasure in the plays of which we are now speaking. They belong for the most part to the earlier period of Shakespeare's career; and though they differ much both in kind and degree of merit, they will be found to be generally distinguished by the characteristics, both positive and negative, of which we have spoken from others of Shakespeare's plays. To this class belong *Love's Labour's Lost*, *Two Gentlemen of Verona*, *The Comedy of Errors*, all written certainly before 1598; *Much Ado about Nothing* (1598), published in 1600; *Twelfth Night*, acted not more than two years later; and the *Taming of the Shrew*, of which the actual date cannot be established, and *All's Well that Ends Well.*

Higher in their aim are those comedies in which the interest of the play centres not more upon the story embodied in it, or the poetical or humorous incidents to which it gives rise, than upon the study either of characters conspicuous and strongly marked in themselves, or of characters ordinary in themselves but developed by the force of circumstances into something of exceptional interest. To this class may most properly be referred the *Merchant of Venice*, an early play, certainly in existence before 1598; *As You Like It*, written not later than 1600; and *Measure for Measure*, a play probably of somewhat later date, perhaps 1603.

The *Midsummer Night's Dream* stands alone in some respects, not only among the plays of Shakespeare, but among all plays. Perhaps no play ever written gives more delight to every reader. The wonderful contrast between the airy delicacy of the fairy world and the coarseness of the human world with which it is brought into contact; the fanciful incidents, such as the misplaced affection of the Fairy Queen, which in a mortal would have been repulsive, but in the pygmy queen has all the charm of grotesqueness and incongruity; the free play which the poet has given to a teeming imagination and a graceful fancy, and the unequalled beauty and music of its language, combine to give to this play a charm quite peculiar. It was an early play, one probable date being 1593–4.

Not wholly dissimilar in its spiritual actors, though very unlike in its general character, is the *Tempest*. The magic, the supernatural powers and agencies in the play are scarcely less fantastic or less original in conception than those of the *Midsummer Night's Dream*, but they are under human control, and their workings are subordinated to the human interests of the play. The *Tempest*, so far as can be traced, must be accepted as one of Shakespeare's latest plays.

Two more comedies remain to be noticed. The *Merry Wives of Windsor* is not only one of the most humorous—perhaps the most so—of all Shakespeare's comedies, but it is also the only one essentially English in character, and which may probably be accepted as substantially a picture of English life and manners in the poet's own day. This play was printed in 1602.

The *Winter's Tale* is one of those plays which one hesitates whether to class under the head either of tragedy or comedy, though for want of a better title it must be called by the latter name. It is one of the most serious as well as one of the most beautiful of Shakespeare's comedies. As far as can be ascertained, it appears to be among the latest of his works (1610–11).

HISTORICAL PLAYS.

The historical plays are ten in number. They are founded on the most striking portions of English history, and the most suitable for dramatic treatment, during a period commencing with the reign of King John and ending with that of Henry VIII.; but the special historical story with which the greater number of them deal is that which includes the various phases of the contest between the rival houses of York and Lancaster. These historical plays might, many of them, be properly classed under the head of tragedies. Some of them, especially the wonderful play of *Henry V.*, it might be difficult to class either as a tragedy or a comedy. But they are properly treated as a class apart from either, because the interest they excite and the emotions to which they are addressed are in many respects peculiar. Shakespeare, no doubt, was too good an artist not to select those precise scenes from history which enabled him to present the most perfect drama upon the stage, and he unquestionably did not hesitate to sacrifice historical accuracy to dramatic effect, and bring events close together which, in fact, though connected as cause and effect, were separated by long intervals of time. But, after making all possible allowance for this, and for the marvellous skill with which Shakespeare has handled his materials, it nevertheless remains true that the historical plays interest us, not merely as plays, or merely as similar plays founded upon like scenes in the history of some foreign nation could do: they attract us as scenes from the youth of our own nation, they appeal to our spirit of nationality, our emotion of patriotism And this must have been so to a far greater extent in Shakespeare's own day, when books were scarce, when the scenes presented upon the stage were less remote from men's own experience, and when the habit of learning, and especially of learning historical and religious truth, through the medium of dramatic representations had not yet died out.

The earliest in the order of history of Shakespeare's plays of this class is *King John*. The story of this reign, and especially the contest between England and the Papacy, affording as they did so much to stimulate the national spirit, and so much that bore upon the religious controversies of the Elizabethan age, had more than once been chosen by dramatic writers. Thus we have already seen that Bishop Bale wrote upon this story soon after the commencement of Elizabeth's reign. And Shakespeare himself was unquestionably much indebted in this play to an earlier drama upon the same subject which is still extant. But though this is so, there is hardly any of the historical plays which more distinctly bears evidence throughout of the genius of Shakespeare. The management of the plot, the drawing of the characters, the intensely pathetic interest of the story of Prince Arthur, and the beauty of the language, all are essentially Shakespeare's, and combine to place *King John* in the first rank among the historical plays. It is among the earlier of Shakespeare's plays, as we know from its being mentioned by Meres in 1598.

Richard II. takes the second place in Shakespeare's historical gallery. It is founded upon the story of the latter part of the reign of the unfortunate king whose name it bears—his decline and fall. That story was in itself so essentially dramatic in its character, the sequence of events, the chain of cause and effect—vice and folly and arrogance working out their own punishment—were so clear, that Shakespeare, though he has not scrupled to alter the details of history when his art required it, has done so in this play far less than in most. This, too, stands among the very first in merit of the historical plays. The conduct of the story is supremely skilful, and the character of Richard II.—weak, passionate, insolent in prosperity, despondent in adversity, yet with fitful flashes of kingly dignity, showing us the higher nature which had once suppressed by leading the rising of the commons, and making a character which would otherwise have been contemptible an object always of respectful pity—is one of the most perfect portraits that even Shakespeare ever painted. The exact date of this play cannot be determined, but it is probably about 1594.

The story of the great historic drama of the contests between York and Lancaster is resumed in the two plays upon the reign of Henry IV. The main story of the first part of *Henry IV.* is that of the rebellion of the Percys and the battle of Shrewsbury; that of the second part treats of the close of the king's reign. And so much of the play as deals with such events—the lives and deeds of kings and nobles, especially the picture of the cares and burdens of royalty in the person of the king—is masterly. But the peculiar charm of these plays lies in the contrast perpetually occurring between the life of the Court and the business of the State on the one hand, and the wild Bohemian life of Prince Hal and his dissolute companions on the other. The inimitable character of Falstaff would by itself be enough to immortalise these plays. The first part of *Henry IV.* was printed in 1598, the second not till 1600. But there are strong reasons for believing that the latter was in existence some considerable time before it was printed.

Henry V. takes up the thread of the story of the houses of York and Lancaster at the period of the great glory of the Red Rose, as well as of the English nation. The subject is the reign of Henry V., the battle of Agincourt, and the conquest of France. The plot of the play has little of dramatic completeness about it: it is almost more a series of scenes of national triumph than a connected narrative. And, probably with a clear consciousness of this fact, Shakespeare has here alone introduced between the acts a chorus, or short spoken narrative, connecting what has gone before with what is to follow. But what above all supplies the place of unity of action in this most remarkable play is the unity of sentiment which pervades it—the almost passionate spirit of patriotism and national pride which breathes in every line of it, and to which everything is subordinated. This play probably belongs to about the same period as the preceding two; it was first printed, though in a very imperfect form, in 1600.

The plays on the events of the next reign and the

Wars of the Roses—the first, second, and third parts of *Henry VI.*—have been always attributed to Shakespeare, and, ever since the first folio edition of 1623, always printed among his works; and for this reason we can hardly doubt that Shakespeare had some share in the production of the plays as they now stand, but how large must remain uncertain. The very most that can be said for them is that Shakespeare adapted and made some alterations in older plays upon the same subjects; and they have no claim to take rank with those which have gone before them.

Richard III. contains passages of equal merit with any in Shakespeare's plays. But, as a whole, it can scarcely be placed on the same level with his greatest historical plays. It is not improbable that it was among the earliest of his works. It was certainly printed in 1597.

Henry VIII., partly written by Fletcher, concludes the series of the histories. It was probably the latest written play of its class, and was first printed in the folio of 1623.

TRAGEDIES.

The tragedies of Shakespeare, including in the number a few of which the authorship remains a matter of some doubt, are thirteen in number. The earliest among them, as far as can be ascertained, and one of the earliest, probably, of Shakespeare's plays, is *Titus Andronicus*, which was probably published as early as 1588 or 1590; but, though always attributed to Shakespeare, its authorship is very doubtful. This was followed by *Romeo and Juliet* in 1591 or 1596–7, which is one of the most beautiful and affecting, and one of the most profoundly tragic of plays, differing from the later and grander tragedies of the poet much in the same way that the class of comedies which includes most of the earlier ones does from *As You Like It* and *Measure for Measure*: it has not the same profound analysis of character; the passion with which it deals is but the one passion of love. The sorrows of the lovers interest us, not their characters. Their fate moves us to pity, but it excites neither awe nor horror.

Troilus and Cressida is founded on a well-known story supposed to have occurred during the siege of Troy, which had often before been used by poets, and notably by Chaucer. But Shakespeare's treatment of the story and his conception of the characters are essentially original. There is scarcely any one of his plays in which the characters stand out from the canvas more clearly or with more thoroughly marked individuality. The date of this play cannot be fixed, but it is certainly not later than 1609.

The three tragedies founded upon events in the history of Rome, *Coriolanus*, *Julius Cæsar*, and *Antony and Cleopatra*, are, no doubt, all late plays. Few of Shakespeare's plays have acquired a more general popularity than these, especially *Julius Cæsar*. In them Shakespeare has followed for the most part the translations of classical authorities within his reach with the same fidelity with which, in his histories, he followed Holinshed and the other chroniclers, but without ever losing his own originality of treatment or sacrificing the life-likeness of the characters.

The tragedy of *Pericles, Prince of Tyre*, was ascribed to Shakespeare by Meres as early as 1598, and it is difficult, therefore, to deny that he took some part at least in modifying or improving it. But the character and style of the play support the view which most readers would wish to adopt, that Shakespeare was not its author.

Timon of Athens is a masterly study of character, and a most powerful play upon the well-known story of the prodigal turned misanthrope. *Cymbeline* is founded on a story borrowed from that source to which Shakespeare was fond of turning—the early legendary history of Celtic Britain. Both of these were probably late plays.

It remains only to mention the four greatest of Shakespeare's tragedies, the four which stand out from among his plays as he himself does among the dramatists. *Hamlet*, *Othello*, *King Lear*, and *Macbeth* are incomparably the greatest works of their kind in the English language. They all belong to the period of the fullest maturity of Shakespeare's powers. *Hamlet*, in its first form, was printed in 1603; *Othello* can be traced to about the same date; *King Lear* to some five years later; and *Macbeth* belongs to the same period. Different as their subjects are—the mental conflict of the Danish prince, the jealousy and crime of the brave Moor, the wrongs and madness of the aged king, the blind ambition of the Scottish usurper—they are alike in the power that they display, the skill to depict every phase of passion, to detect and follow every conflict or doubt which can torment the human soul. They are alike in truth to nature, in artistic judgment, in mastery over all the elements of pity, of horror, of fear, in boundless fertility of imagination, and in the irresistible spell which they exercise over every mind. We have not space in these pages to criticise or examine them. We can only impress upon our readers that, more than any other of the works we have had occasion to mention in the course of these lessons, they must be read and re-read, diligently and patiently studied, by every genuine student and lover of English literature.

COMMERCIAL CORRESPONDENCE.—VI.

[*Continued from p.* 263.]

FRENCH, GERMAN, AND ENGLISH.

31.—LETTER ON PAYMENT OF ACCOUNTS FOR ANOTHER, ETC.

Lyons, February 9th, 1891.

M. Armand, jun., Paris.

Sir,—In reply to your esteemed favour of the 5th inst., I beg to state that I have paid the accounts as desired, and debit you as follows :—

1st. According to the enclosed receipt of Ch. Aurigny of our town		fr. 328 25 c.
2nd. Made good Messrs James Barker & Co., Amiens, in account current		„ 1,311 40 „
3rd. Cash forwarded per diligence to M. Martin le Tourneur, Fécamp . . .	fr. 195 85 c.	
Packing and Postage	„ 1 65 „	„ 197 50 „
value the 8th February.	Total	fr. 1,837 15 c

I have most willingly undertaken the slight trouble which these payments have occasioned ; you need not therefore make yourself at all uneasy on that account. I execute your commissions with pleasure, and shall be delighted if a lucrative commercial speculation should offer itself in our town You may rest assured that your interest will always meet my most scrupulous care

Referring you to our enclosed price-current, I beg you to observe that our business in lace is very good this winter, our imitation Valenciennes and Caen Blonde being particularly in demand. It must be admitted that the first-mentioned article is a wonderful imitation, and can be offered much cheaper than the real.

Awaiting further communications,

I have the honour to remain, Sir,

Yours very truly,

LÉON TAVEL.

Lyon, le 9 *février*, 1891.

M. Armand fils, à Paris.

Monsieur,—En réponse à votre honorée du 5 courant, j'ai l'avantage de vous faire part que j'ai payé les différentes sommes que vous m'avez commises et que je vous en débite comme suit :—

1° Selon le reçu ci-inclus de Ch. Aurigny de notre ville . .		fr. 328 25 c.
2° Bonifié à MM. James Barker & C^ie^, d'Amiens, en compte courant		„ 1,311 40 „
3° Envoyé à M. Martin le Tourneur, Fécamp par la diligence	fr. 195 85 c.	
Pour port et emballage . .	fr. 1 65 c.	fr. 197 50 c.
Total . . .		fr. 1,837 15 c.

le tout au 8 février.

Je me suis chargé volontiers du petit embarras que ces paiements m'ont donné, et vous ne devez pas vous en inquiéter. C'est avec plaisir que je prends soin de vos commissions et je serai charmé qu'une affaire lucrative sur notre place vienne s'offrir à vous. Vous pourrez être assuré que vos intérêts seront toujours l'objet de mes soins les plus scrupuleux.

En vous référant à notre prix courant ci-inclus, je vous fais observer que notre dentellerie va parfaitement bien cet hiver ; ce sont principalement nos Valenciennes et nos Blondes de Caen contrefaites qui sont en grande vogue ; mais il faut avouer qu'on sait à merveille imiter les articles de cette catégorie, et qu'on les livre à beaucoup meilleur marché que les originaux.

En attendant vos communications ultérieures,

J'ai l'honneur d'être, Monsieur,

Votre très-dévoué,

LÉON TAVEL.

Lyon, 9 Februar, 1891.

Herrn Armand junr, Paris.

In Beantwortung Ihres Geehrten vom 5 curr mache ich Ihnen die Mittheilung, daß ich die Rechnungen wie folgt zu Ihren Laſten bezahlt habe.

I. Laut einliegender Quittung von Ch Aurigny hier		fs. 328 25
II. Herrn James Barker & Co, Amiens, im Conto Corrent gutgebracht .		„ 1,311 40
III. Caſſa per Eilpoſt an Herrn Martin le Tourneur, Fécamp, geſandt .	fs. 195 85	
Packung und Porto . .	„ 1·65	„ 197·50
Werth 8 Februar.	Summa	fs. 1,887·15

Ich habe mich der kleinen Mühe, welche dieſe Zahlungen verurſachte, ſehr gerne unterzogen, und konnen Sie hierüber ganz ruhig ſein Ich führe Ihre Orders mit Vergnügen aus, und werde mich ſehr freuen, wenn ſich eine einträgliche geſchäftliche Speculation in unſerm Platze darbieten ſollte. Sie können darauf rechnen, daß Ihre Intereſſen ſtets meine gewiſſenhafteſte Aufmerkſamkeit haben werden.

Indem ich mich auf einliegende Preisliſte beziehe, bemerke ich, daß unſer Geſchäft in Litzen in dieſem Winter ſehr gut iſt, und erfreuen ſich unſere Nachahmungen Valenciennes und Caen Blonde einer ſpeciellen Nachfrage. Man muß zugeben, daß der erſtere Artikel eine wundervolle Nachahmung iſt und ſich viel billiger als der echte herſtellen läßt.

Ihrer weiteren Mittheilungen gewärtig zeichne ich.

Hochachtungsvoll,

Léon Tavel.

32.—Acknowledgment of Bill of Lading, etc.

The Hague, July 9th, 1891.

Messrs. Van Steen, Gniyten & Co., Rotterdam.

Gentlemen,—We received, with your esteemed favour of the 16th inst., the bill of lading for—M & C, 18 bales of Tobacco shipped per *Clara*, but the bill of exchange of

Florins 1,280, on Asher & Co., Frankfort, mentioned in your letter as being enclosed, was wanting.

We hasten to inform you of the fact, so that, if it is not a slight inadvertence merely, you may take the necessary measures to protect yourselves from loss.

Having nothing further to add to-day, we beg leave to sign ourselves with respect,

Gentlemen, your humble servants,

J. Terenaer & Sons.

La Haye, le 9 juillet, 1891.

Messrs. Van Steen, Gniyten, & C^{ie}, à Rotterdam.

Messieurs,—Nous recûmes avec votre honorée du 16 courant le connaissement pour 18 balles de Tabac M & C par la *Clara*, chargées à notre adresse, mais la lettre de change dont vous parlez comme y étant incluse de

Florins 1,280, sur Asher & C^{ie}, à Franckfort, ne s'y trouvait point.

Nous nous empressons par conséquent de vous en donner connaissance, afin que s'il n'y a qu'une petite erreur, vous fassiez les démarches nécessaires pour vous garder d'une perte.

Nous n'avons rien à ajouter aujourd'hui et sommes,

Vos humbles serviteurs,

J. Terenaer & Fils.

Haag, 9 Juli, 1891.

Herren Van Steen, Gniyten & Co., Rotterdam.

Ihr Geehrtes vom 16 curr. überbrachte uns Connaiſſement über M & C, 18 Ballen Tabak per „Clara" verſchifft, während der Wechſel von

Gulden 1,280 auf Aſher & Co. in Frankfurt, in Ihrem Brief aufgeführt, fehlte.

Wir beeilen uns, Sie hiervon zu benachrichtigen, damit Sie die nöthigen Maßregeln treffen können um ſich vor Verluſt zu ſchützen, falls es ſich nicht nur um ein Verſehen handeln ſollte.

Ohne mehr für heute, zeichnen wir mit vorzüglicher Hochachtung,

J. Terenaer & Söhne.

33.—Letter announcing Refusal of Acceptance.

Manchester, July 6th, 1891.

Messrs. Walton Bros., Birmingham.

Gentlemen,—As you will have seen by our telegram of this morning, which we beg to confirm, Messrs. Dashwood & Co. have refused the payment of their acceptance for

£500, due to-day,

stating they had not the necessary funds in consequence of the non-arrival of some remittances they expected.

They promise, however, to honour your draft in a few days. We have had a protest made out, and shall keep it together with your bill, awaiting your instructions whether you wish to have it returned or not.

We are, Gentlemen, yours truly,

James Anstruther & Co.

Manchester, le 6 juillet, 1891.

Messieurs Walton Frères, à Birmingham.

Messieurs,—Comme vous l'aurez appris par notre dépêche télégraphique de ce matin, que nous vous confirmons, Messieurs Dashwood & C^{ie} ont refusé le paiement de leur acceptation de

£500, payable aujourd'hui,

disant qu'ils n'avaient pas les fonds nécessaires par suite de faute d'arrivée de quelques remises qu'ils attendaient.

Ils promettent cependant de payer votre traite sous quelques jours. Nous avons fait faire le protêt que nous garderons avec l'effet en attendant vos instructions, si nous devons vous le retourner ou non.

Recevez, Messieurs, nos salutations amicales,

James Anstruther & C^{ie}.

Mancheſter, 6 Juli, 1891.

Herren Walton Brüder, Birmingham.

Wir beſtätigen hiermit unſer Telegramm von heute früh, aus dem Sie erſehen haben werden, daß Herren Daſhwood & Co. die Zahlung Ihres Accepts von

£500 heute fällig,

verweigerten, unter dem Vorgeben, daß ſie in Folge von Ausbleiben einiger Rimeſſen nicht die nöthigen Gelder in Händen hätten.

Sie verſprechen übrigens, Ihre Tratte in einigen Tagen einzulöſen. Wir haben einen Proteſt veranlaßt, und werden ihn zuſammen mit Ihrer Tratte hierhalten, während wir von Ihnen zu hören erwarten, ob wir die Papiere an Sie zurückſenden ſollen oder nicht.

Hochachtungsvoll,

James Anſtruther & Co.

34.—Letter about Dishonoured Acceptance.

Birmingham, July 7th, 1891,

Messrs. Dashwood & Co., Manchester.

Gentlemen,—We have just been informed, to our great surprise, by our banker that you refused the payment of your acceptance for

£500, due yesterday,

saying you had not the necessary funds to meet it.

As the bill was drawn at three months from the date of our invoice, we are really much astonished to hear of your using the above pretext, for you had plenty of time to provide the money.

We hear that you promise to pay in a few days. and therefore allow you till the end of this week; but if at that time the bill is not honoured, we shall be under the necessity of putting the matter into the hands of our solicitor.

We are, Gentlemen, yours truly.
J. & H. WALTON.

Birmingham, le 7 juillet, 1891.

Messieurs Dashwood & Cie, à Manchester.

Messieurs,—Nous venons d'apprendre à notre grande surprise par notre banquier, que vous avez refusé le paiement de votre acceptation de

£500, payable hier,

en disant que vous n'aviez pas les fonds nécessaires pour y faire honneur.

L'effet étant tiré à trois mois de la date de notre facture, nous sommes vraiment très-étonnés d'apprendre que vous ayez donné ce prétexte, car vous avez eu tout le temps de vous procurer l'argent.

Comme l'on nous écrit que vous promettez de payer dans quelques jours, nous vous allouerons jusqu'à la fin de la semaine; mais si à cette époque la traite n'est pas payée, nous serons dans la nécessité de mettre l'affaire entre les mains de notre avoué.

Nous vous présentons, Messieurs.
Nos salutations empressées,
J. & H. WALTON.

Birmingham, 7 Juli, 1891.

Herren Daſhwood & Co, Mancheſter.

Wir werden ſoeben zu unſerer großen Überraſchung durch unſeren Banquier davon benachrichtigt, daß Sie die Zahlung Ihres Accepts von

£500, geſtern fällig,

verweigert haben, mit dem Bemerken daß Sie die nöthigen Gelder dafür nicht in Händen hatten.

Da die Tratte 3 Monate vom Datum unſerer Factura gezogen war, ſind wir wirklich ſehr erſtaunt uber Ihre Ausrede, während Sie doch genügend Zeit zur Beſchaffung des Geldes hatten

Wir hören, daß Sie verſprachen in einigen Tagen zu zahlen, und bewilligen dafür Zeit bis zum Ende dieſer Woche, ſollte der Wechſel bis dahin nicht eingelöſt ſein, ſo werden wir uns genöthigt ſehen, die Sache unſerm Rechtsanwalt zu übergeben.

Achtungsvoll,
J & H. Walton.

35.—LETTER ON REFUSAL OF ACCEPTANCE, ETC.

***London, June 30th*, 1891.**

Messrs. Roussel & Co., Paris.

Gentlemen,—Confirming our letter of the 26th, we herewith beg to inform you that the drawees of your remittance for

£50 0 0 22/25 June

have refused acceptance.

We have therefore had this bill noted, and await your instructions by return, stating whether you wish the protest extended.

We remain, Gentlemen, yours truly,
G. DALLAS & CO.

***Londres, le 30 juin*, 1891.**

Messieurs Roussel & Cie, à Paris.

Messieurs,—En vous confirmant notre lettre du 26, nous venons vous informer par la présente que les tirés de votre remise de

£50 0 0 au 22/25 juin

ont refusé l'acceptation.

Nous avons donc fait notifier cette traite, et attendons vos instructions par retour du courrier si vous désirez la faire protester ou non.

Recevez, Messieurs, nos sincères salutations,
G. DALLAS & Cie.

London, 30 Juni, 1891.

Herren Rouſſel & Co, Paris.

Unter Beſtätigung unſeres Ergebenen vom 26 curr. benachrichtigen wir Sie hiermit, daß die Bezogenen Ihrer Rimeſſe von

£50 per 22/25 Juni

Accept verweigert haben.

Wir haben daher dieſen Wechſel notiren laſſen, und erwarten Ihre umgebenden Inſtructionen, ob wir Proteſt vornehmen laſſen ſollen

Hochachtungsvoll,
G. Dallas & Co.

36.—LETTER ON EXTENSION OF PROTEST.

London, July 8th, 1891.

Messrs. Roussel & Co, Paris.

Gentlemen,—In accordance with the instructions contained in your favour of yesterday, we have had the protest extended on your remittance for

£50 0 0 payable June 25th,

and we enclose it herewith, debiting your account with 5/6 for cost of same.

We subjoin an exchange list, and are,
Gentlemen,
Yours faithfully,
G. DALLAS & CO.

***Londres, le 8 juillet*, 1891.**

Messieurs Roussel & Cie, à Paris.

Messieurs.—Conformément aux instructions contenues dans votre honorée d'hier, nous avons fait faire le protêt à votre remise de

£50 0 0 au 25 juin,

que nous vous remettons sous ce pli, débitant votre compte de 5/6 pour frais.

Nous vous adressons une liste de change, et

Vous saluons, Messieurs,
Bien sincèrement,
G. DALLAS & C^{IE}.

London, 8 Juli, 1891

Herren Rouſſel & Co., Paris.

Laut den uns mit Ihrem werthen geſtrigen ertheilten Inſtructionen ließen wir Ihre Rimeſſe von

£50 per 25 Juni

proteſtiren, und ſenden Ihnen dieſelbe einliegend, indem wir Ihr werthes Conto mit 5/6 Koſten belaſten.

Wir fügen unſere Cursliſte bei und zeichnen,

Hochachtungsvoll,
G. Dallas & Co.

37.—LETTER ON SUSPENSION OF PAYMENT.

London, January 6th, 1891.

Messrs. Carlton & Co., Manchester.

Gentlemen,—Referring to our letter of yesterday, we beg to inform you that the creditors of Messrs. Chapple & Co. could not come to an understanding at the meeting which took place this morning, and that consequently the latter have been compelled to suspend payment.

We therefore beg of you to send us by return of post the necessary documents stating your claims, so that we may get them registered at once.

We are, Gentlemen, yours truly,
HENRY DAMPIER & CO

Londres, le 6 *janvier*, 1891.

Messieurs Carlton & C^{ie}, à Manchester.

Messieurs,—En vous référant à notre lettre d'hier, nous avons l'avantage de vous informer que les créanciers de Messieurs Chapple & C^{ie} n'ont pu arriver à un arrangement à la réunion qui a eu lieu ce matin, et que conséquemment ces messieurs ont été obligés de suspendre leurs paiements.

Nous vous prions donc de nous envoyer par retour du courrier les documents nécessaires constatant votre créance, afin de les faire enregistrer de suite.

Agréez, Messieurs, nos salutations empressées,
HENRY DAMPIER & C^{IE}.

London, 6 Januar, 1891.

Herren Carlton & Co., Mancheſter.

Mit Bezugnahme an unſer ergebenes Geſtriges erlauben wir uns Ihnen mitzutheilen, daß die Creditoren der Herren Chapple & Co. bei der heute ſtattgefundenen Verſammlung ſich nicht einigen konnten, und daß dieſe Firma ſich in Folge deſſen genöthigt ſieht, ihre Zahlungen einzuſtellen.

Sie wollen uns daher mit Poſtwendung die nöthigen Papiere mit Ihren Forderungen gegen die Firma einſenden, damit wir ſie ſofort eintragen laſſen können.

Hochachtungsvoll,
Henry Dampier & Co.

38.—LETTER ON TRANSMISSION OF POWER OF ATTORNEY.

Lyons, February 18th, 1891.

Messrs. Denbigh & Co., London.

Gentlemen,—Taking advantage of your kind offer to represent us at the creditors' meeting of the estate of the Eau-de-Vie Company, Limited, we now beg to hand you the necessary powers of attorney and documents stating our claims.

Fortunately, we are not interested to a very large extent, and therefore do not wish to make any suggestions as to the winding-up, but leave it entirely in your hands to act for us and in our name as you may think proper.

Agreeing beforehand to all you may be pleased to do for us in this matter,

We remain, Gentlemen, yours truly,
ALPHONSE CARTIER & SON.

Lyon, le 18 *février*, 1891.

Messieurs Denbigh & C^{ie}, à Londres.

Messieurs,—Profitant de votre aimable offre de nous représenter à la réunion des créanciers de la Compagnie de l'Eau-de-Vie, Société à responsabilité limitée, nous prenons la liberté de vous remettre, sous ce pli, les pleins pouvoirs et documents constatant notre créance.

Nous ne sommes pas intéressés, heureusement, pour une forte somme, et pour cette raison nous ne désirons pas faire de suggestions relativement à la liquidation, préférant laisser l'affaire entièrement entre vos mains, et vous priant d'agir pour nous et en notre nom tout-à-fait d'après votre opinion.

Inutile de vous dire que nous approuvons d'avance tout ce qu'il vous plaira de faire pour nous dans cette affaire.

Recevez, Messieurs, nos sincères salutations,
ALPHONSE CARTIER & FILS.

Lyon, 18 Februar, 1891.

Herren Denbigh & Co., London.

Von Ihrem gütigen Anerbieten uns bei der Verſammlung der Gläubiger der Maſſe „Eau de Vie Company, Limited" zu vertreten, gerne Gebrauch machend, erlauben wir uns hiermit, Ihnen die nöthige Vollmacht ſowie die Papiere mit unſerer Klage zu überſenden.

Glücklicherweiſe ſind wir nicht mit einer ſehr großen Summe betheiligt, und wünſchen deshalb nicht, irgend welche Andeutungen betreffs der Liquidation zu machen, überlaſſen es vielmehr ganz Ihnen, für uns und in unſerem Namen nach beſtem Ermeſſen vorzugehen.

Wir erklären uns im Voraus mit allen Ihren Schritten in dieſer Sache einverſtanden, und zeichnen,

Hochachtungsvoll,
Alphonſe Cartier & Sohn.

ARCHITECTURE.—IX.

[Continued from p. 269]

ENGLISH GOTHIC

As the introduction of the pointed arch and the changes consequent on its adoption took place first in France, and have been entered into at some length in our last lesson, it will only be necessary, in dealing with English Gothic, to point out the principal differences which are found in the latter We may note that, whilst in France the terms thirteenth, fourteenth, and fifteenth century are usually adopted to define the limits of change in that country (though they are about half a century too late in the two first), in England we owe our nomenclature to the researches of the late Mr Thomas Rickman, who, in 1855, published a work in which he defined the gradual changes which had taken place in the development of English Gothic, and ascribed specific terms to each phase Early-English, from 1189 to 1272, Decorated, from 1272 to 1377, and Perpendicular to about the middle of the sixteenth century The two first, therefore, broadly speaking, lasted about a century each

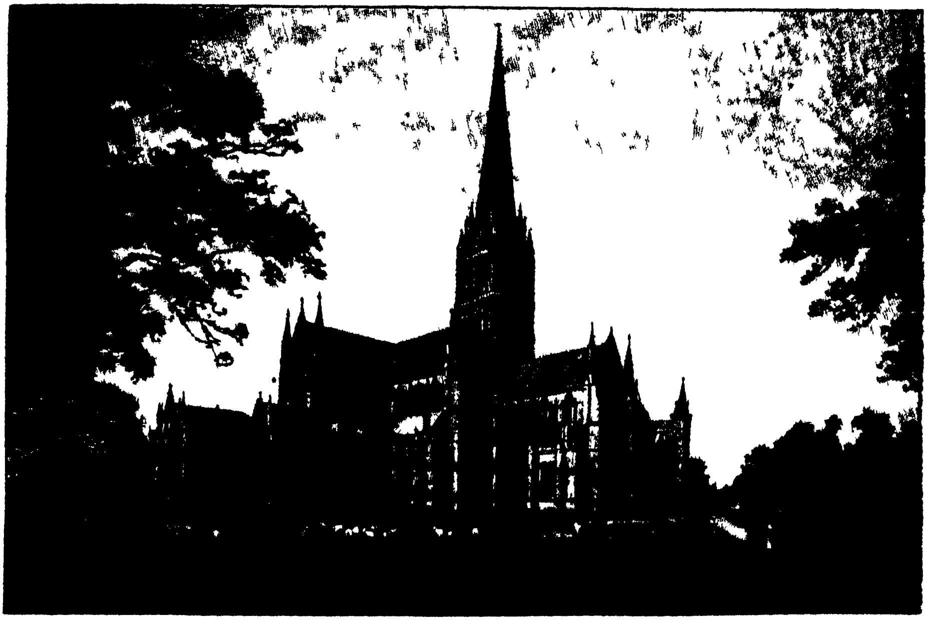


Fig 34 —Salisbury Cathedral. *(From a Photograph by G W Wilson & Co , Aberdeen)*

Owing, however, to the acute and strongly marked form of the lancet arch, which was the characteristic feature of the Early-English style, to its elaborate and deeply cut mouldings, and their complete contrast with the Norman style which preceded it, there exists in England that which is known as the Transition style between the two, and which Rickman places as between 1154 and 1189. If it were placed ten years later in both cases, it would better accord in date with the examples existing The chief characters of the Transition or Semi-Norman style, as Bloxam calls it, are —(1) The admixture of round and pointed arches not in the sense as used in France, where the wider opening is spanned by a pointed arch, and the narrower by a circular arch, but, in fact, the contrary; the central arch of a doorway, for instance, will be circular and be flanked by two narrow niches with lancet arches the top of each being on the same level (2) The more frequent use of mouldings in the arches instead of the richly-carved conventional Norman ornament (3) The introduction of more elegant forms in the conventional foliage of capitals than is found in Norman work

The finest example of the Transition and the building in which the pointed arch was first introduced into England in the vaulting ribs, is found in the choir of Canterbury Cathedral. Owing to a disastrous fire in 1174, that which was known as the "glorious choir of Conrad" was burnt to the ground. In the following year French and English artificers were summoned, and from them the services of William of Sens were retained. If not the actual architect of Sens Cathedral he must have been one of the chief master masons there, and we might, therefore, expect to find, as is actually the case, some reflection of the style employed in that building. He carried out the first four bays of the choir eastward of the transept, and from the fact that English and French ornament is found in them we may assume that he had workmen under him of both nationalities. The work was continued by William the Englishman, "an industrious and ingenious monk," who had been overseer of the masons. In the choir itself William the Englishman retained the French features as set out by William of Sens, viz., the double or twin columns, and the square abaci to the capitals, both of which exist at Sens, but in the eastern portion of the choir (known as the Trinity Chapel or Chapel of St. Thomas à Becket, and containing his shrine) he employed circular arches instead of pointed for the arches opening to the aisle. In the new crypt also, which had to be erected under the Trinity Chapel, he returned to the original distinctive feature of English work as compared with French, viz., the circular capital to the piers. There are other features in the triforium which show the early divergence between English and French Gothic.

Another Transitional building is the circular porch of the Temple Church in London, which is contemporary with the choir of Canterbury, having been consecrated in 1185. Here the abaci of the columns are square, and the arches and ribs all pointed; the triforium, however, and the clerestory windows above all retain the circular form of arch.

Chichester Cathedral again, somewhat later than Canterbury, in its eastern portions shows the gradual change from Norman to Early-English, and is a good example of Transition work, as are also the choir of Tynemouth Abbey, the Lady Chapel of Glastonbury Abbey, and Hexham Abbey.

The first typical example of the Early-English style is found in the eastern transept and choir, and the east side of the great transept of Lincoln Cathedral. Already in the Norman period the English cathedral shows a marked contrast to the French in its great length when compared with its width; whilst the general proportion of width to length in the latter is 1 to 4, in England it more often approaches 1 to 6. The great width of French cathedrals includes not only the nave and aisles, but chapels, which have been at a later period added on each side both of the nave and choir aisles. In England the additional altar space was afforded, first, by a greater projection of the transepts, which could hold three altars on each side (the French having only space for one), and, secondly, in an additional transept called the eastern transept. In English Norman cathedrals the apsidal termination is still kept to, and sometimes with eastern chapels, such as are still preserved in Norwich and in Canterbury, but from the thirteenth century onwards the English architects returned to an earlier plan, the square east end, which forms the most essential characteristic in the cathedrals of the two countries. The English cathedrals were also, as a rule, built in a close, outside the town, where, as isolated features, those double transepts gave that play of light and shade which is requisite when thus placed; the French cathedrals, on the other hand, were built in the midst of populous towns, and could only be seen down the narrow streets in their vicinity. Another characteristic feature of English cathedrals is the great central tower, which rises on the "crossing," as it is then called, viz., the intersection of the nave and transept, which is rarely found in France, and does not exist in any of the examples we have quoted, its place being taken by what is known as a *flèche*, a lofty construction in timber covered with lead, which is raised on the intersection of the nave and transept roofs.

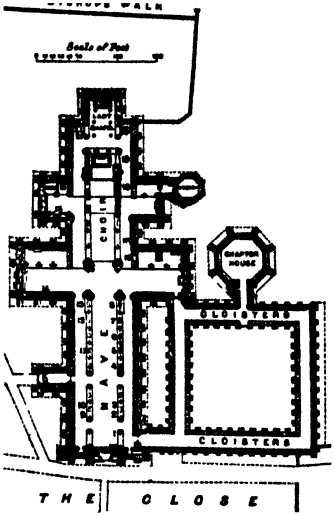


Fig. 35.—PLAN OF SALISBURY CATHEDRAL.

A. Audley Chapel, B. Hungerford Chapel; 1, Bp. Herman, 2 Bp Jocelyn; 3 Bp. Roger; 4, Bp. Beauchamp, 5, Lord Hungerford; 6, Lord Stourton 7. Bp de la Wyle, 8, William Longsword; 9, Boy Bishop, 10, Earl of Salisbury II; 11, Sir John de Montacute, 12, Walter Lord Hungerford; 13, Sir John Cheyney, 14, Earl of Malmesbury; 15, Bp. Wyville; 16 Bp. Mitford, 17, Sir R Mompesson; 18, Bp. Giles de Bridport; 19, Bp Hamilton, 20, Earl of Hertford, 21, Sir Thomas Gorges

Returning again to Lincoln Cathedral, the eastern transept is the earliest example of that feature; this and the choir may be looked upon as constituting the first genuine example of English Gothic. We should be surprised to find so perfect a development of the style, and one which presents so great a contrast with French work of the same period, were it not for the fact that in the neighbouring county of Yorkshire, so rich in its abbeys, the monks had already been developing a style peculiar to England, and of which here we see the natural outcome. The chief characteristics are, first, the circular abacus to the capital instead of the French square abacus; second, the deep undercut moulding instead of the simple angle roll, as in France; and third, the great difference in the system of vaulting, which necessitated the use of ridge ribs at the apex of the vault, and intermediary ribs between the diagonal and the transverse or the wall rib. Both these features are found in Lincoln Cathedral, towards the close of the twelfth century. The transept, the nave, the upper part of the west front, the narthex, and a portion of the central tower were all carried out in the first half of the thirteenth century. The presbytery or angel-choir was completed in 1282, and this portion merges therefore in the second great division of English architecture, viz., the Decorated: commenced, however, in 1270, it still retains the greater purity and simplicity of the Early-English style, and is in that sense more to be admired than the later development of the Decorated as found in the choir of Ely Cathedral built fifty years later. The most beautiful feature of this portion of the cathedral (Lincoln) is the north porch, which still retains the greater portion of its figure and ornamental sculpture (except the heads); this in the beauty of the drapery, the pure conventional treatment of the foliage, and the deep undercutting fully holds its own when compared with sculpture of the great French porches.

Fig. 36 — Melrose Abbey.

Coming back to earlier periods, in the western porch of St Alban's Abbey, built 1195–1205, in the west Galilee porch of Ely and in the north porch of Wells cathedrals, we find types of Early-English work of great beauty. We have already drawn attention to the magnificence of the western porches of the French cathedrals. Placed as these cathedrals were in the midst of towns, the French architects would seem to have attached more importance to those features which could be seen from the streets leading to the cathedral. In England, on the contrary, where the cathedrals were placed in a close, the west part receives no more attention than the rest of the edifice; in some cases, in fact, less, where, as above stated, there is a porch on the north or south side. It is to this that perhaps we must attribute the great poverty of what in France is looked upon as the chief part. In the great porch of the cathedral of Peterborough, however, overlooking the main approach to it from the town, we find one example of a grand English porch. It forms a narthex with three lofty arched openings rising to the height of the nave, flanked by two small towers. This was added to the Norman cathedral, and does not accord with the lines of the original plan; the central archway also, instead of being the most important, as leading to the nave, is narrower than the other two, and owing to some constructional defects, has had the lower portion blocked up in the fourteenth century with a small porch which interferes materially with the uniformity of the three arches. Although we miss in this porch that figure sculpture which is the glory of the French cathedrals, the purity of its design, the scale which is given to the whole front by its subdivision and by the arcade work on the three gables which crown the porch, and the faces of the angle towers, give a size and majesty to this portal which raises it above the criticism which one is sometimes inclined to pass on it.

We have already described the *chevet*, which in French cathedrals constitutes one of their most varied and beautiful features; in marked contradistinction we find in Durham Cathedral in the chapel of the nine altars, that which is known as the eastern transept, and which in this case, as also at Fountains Abbey, takes the place of the chevet, and gives additional accommodation for eastern altars.

Still keeping to the earlier cathedrals, in the transept of York, built 1215–50, we have one of the finest features of the Early-English period. Its total width, including aisles, is 93 feet, its length 223 feet, and height to vault 99 feet. Its central vault is 45 feet in span, being the greatest width of any vault in England, though exceeded by many foreign examples. The north side of this transept is lighted by five lofty lancet windows, 50 feet high, which are known as the Five Sisters of York; they are filled with the original early glass, consisting of diaper patterns of great beauty. This type of window is quite unknown in France, and its general acceptance in England, in preference to the open traceried windows which already had spread over the French cathedrals, retarded here that development of window tracery which formed then the ascendant characteristic of the style. The first appearance in England is thought to be in Netley Abbey and in old St. Paul's Cathedral, which may have preceded those which were erected in Westminster Abbey in 1253.

The cathedrals to which we have already referred, excepting York, were all founded under the direction of Norman bishops; and, although there are others which possess characteristic features of the Early-English style, we may now pass on to the typical example of a cathedral founded and completed within the period of that style. With the exception of the upper part of the tower and spire, of the cloisters, and of the chapter house, Salisbury Cathedral, commenced in the year 1220, was completed and consecrated in 1258, having thus taken thirty-eight years to build (Fig. 34). It is a typical example of the style, not only in its design, but in its isolated position in a close. It consists of a nave and aisles with north porch, transept with eastern aisle only, choir and aisles, eastern transept, retrochoir and aisles, and a square eastern chapel.

In comparison with Amiens Cathedral, which was built about the same time, the latter covers an area of 71,000 square feet, as against 55,000 square feet; the vault of Amiens is 145 feet high, that of Salisbury 85 feet. The bulk of one, in fact (or that which is known in architectural parlance as the cubical content), is double that of the other, and yet, although the length is about the same, the cathedral of Salisbury looks much the longer. This apparent length is given, not only by the greater number of subdivisions of the nave and choir, that is to say, the number of bays (of which there are twenty in Salisbury as against thirteen in Amiens), but by the much greater width of Amiens, with its double aisles, and which, by contrast, lessens the length. It is true that in effect of immense internal space and height Amiens takes the first rank, but in apparent length Salisbury looks far longer, though the dimension of the two from east to west is in both cases about 480 feet. The most beautiful portions of Salisbury are the east end—the grouping of the choir with its central and eastern transepts and the tower and spire, which, though of later date, harmonise perfectly with the earlier structure; the spire is the loftiest in England, rising 400 feet above the pavement of the church. The west front is poor in design, and its poverty is increased by the fact that it has lost nearly all its figure sculpture, and that portions of it are simply screens which rise above the aisle roofs.

Wells Cathedral, in this respect, is free from shams; the west front is flanked by two towers, which, if they had been completed, would have rendered it the finest in England. It fortunately also retains the greater portion of its figure sculpture, there being over 300 figures, of which half are life-size or colossal. We possess so little figure sculpture in England that the value of these examples in Wells Cathedral is enhanced, especially as they have been compared favourably by Flaxman and Professor Cockerell with the contemporaneous work of Nicolò Pisano at Orvieto, and with the sculpture at Amiens.

The cathedral of Lichfield, though wanting in figure sculpture, is more fortunate in the completion of its west front, and in the crowning of its two towers with spires, which, with the central tower and spire over the crossing of transept and nave, forms a composition not found elsewhere.

The other chief notable examples of the Early-English style are: the choir of Worcester Cathedral (1203–18); Elgin Cathedral, Scotland (1224–44); Ripon Cathedral (1238–87); the choirs of Rochester Cathedral (1225–39), of Southwell (1233–94), of Glasgow (1242–88); the abbeys of Rivaulx, Whitby, and Tintern; and last, though not least, the choir and transept of Westminster Abbey (1245–69). Westminster Abbey is the only church in England in which the developed form of the chevet, as it exists in France, is carried out. Although the idea was borrowed from that country by Henry III., it was entrusted to English builders to erect in their own way; the radiation of the chapels, the columns with their coupled shafts, the lancet arches with their deep undercut mouldings, and the setting out and building of the vault are all English. In the windows we perhaps find here the first introduction of tracery, unless the examples before quoted can be proved to have an earlier date. The chapter house and vestibule also date within the period above noted, as also the first bay of the nave. This bay served as the model on which the remainder was based, with such slight differences in the contour of the mouldings and detail of ornament as the later periods necessitated, this uniformity of design being remarkable, because the western portions were not even finished in the fifteenth century, and yet to the casual observer the whole of the nave would appear to be of one period. This uniformity is not found in other work; already after the middle of the thirteenth century windows with two or more mullions, and with geometrical tracery in their heads, began to be introduced, the lancet arch gave way to the equilateral arch, and the proportions of the nave and other arches became less lofty. The changes which were being introduced were gradual, and form a kind of transition which eventually transforms the Early English into the Decorated style. The north transept, chapter house, and cloisters of Hereford (1275–82), Merton College, Oxford, and the Eleanor crosses throughout the country belong to this period. The full development of the Decorated style is found in the Lady Chapel of Ely Cathedral (1321–49), which is one of the most beautiful examples in England. The vaulting of this chapel constitutes what is known as a lierne vault. We have already alluded to the ridge and intermediary ribs which in the Early-English work had been introduced in contradistinction to the simple vaulting in France. The lierne rib is a decorative feature only carried across between the other main ribs so as to form star patterns, the intersections being masked by bosses of foliage, which already, in the Early-English style, had been introduced to hide the intersections of the main and subsidiary ribs. The chief feature of Ely Cathedral, however, is the central octagonal lantern, the only example in England.

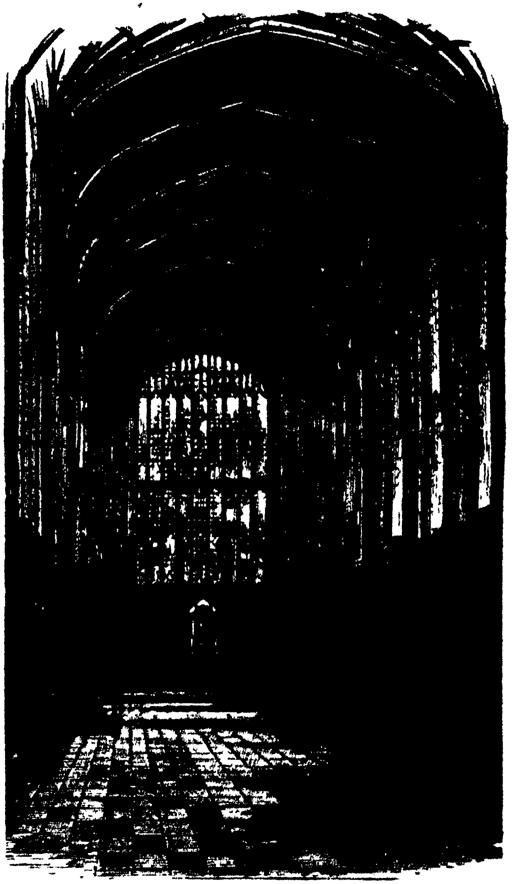


Fig. 87.—King's College Chapel, Cambridge.

The octagon dates between 1322–28, the lantern above it being completed in 1342. The first three western bays of the choir were built in 1342–62 in the rich elevated style, in which, however, the ornament approaches that of wedding cakes, and the carving of the foliage becomes a decided imitation of nature, and is out of keeping with its material. In this respect the ornament of Melrose Abbey (1377-99), is infinitely more beautiful, the foliage still conventional, but of the most delicate character (Fig. 36). Selby Abbey (1375), the nave of Beverly Minster, the church of St. Mary at Beverly, are good examples of the Decorated style. The third phase of English Gothic is known as the Perpendicular or Rectilinear style; it must be looked upon as a reaction against the flowing forms of the Decorated in England and the Flamboyant style in France. At first the arches are equilateral, but they subsequently become four-centred. Windows are occasionally divided by horizontal beams called transoms, and the mullions—that is to say, the vertical divisions—frequently run straight up into the arch. The general tendency of the style is into verticality, and the features which in the earlier periods give distinct horizontal lines, such as the triforium storey, are almost dispensed with. This is seen in the nave of Canterbury Cathedral, built 1380, and in Winchester Cathedral. New College, Oxford, and Winchester College, both built by William of Wykeham, are characteristic examples of that style, and the great east window of York is one of the finest examples of the Perpendicular style.

The multiplication of ribs, which had always formed one of the chief characteristics of English vaulting, and the introduction of the four-centred arch, led to a new construction of vault which is known as the fan-vault, and is peculiar to England. In the fan-vault all the ribs are of an equal radius, and rise to the same height: when the compartments are square, as in the cloisters of Gloucester Cathedral (the earliest example of fan-vaulting), or in the retro-choir of Peterborough, the problem is a simple one; it becomes more complicated where, as in King's College Chapel, Cambridge, they are as usual oblong (Fig. 37). In this case the central portion of the vault is supported on ribs of four centres, and as in so great a width, 44 feet, the smaller ribs of the fan vault would appear unequal to the task, deep transverse ribs are thrown across, which somewhat clash with the fan-vaults at their springing.

Our attention has hitherto been directed to cathedrals and churches, in the design and construction of which the real problems of the development of Gothic architecture were solved. The smaller churches and chapels derive their features mainly from the great ecclesiastical buildings erected in the principal counties, and the same may be said of domestic or secular architecture, which follows on the same lines, except in certain characteristic features. The chief, and, in fact, almost the only architectural feature of the mediæval mansion (excepting the castles and keeps erected for defensive purposes) was the great hall, the earliest example of which is found in Oakham Castle, Rutlandshire, dating from the close of the twelfth century. The largest dating from the close of the fourteenth century is that of St. Stephen's, Westminster, being 234 feet long and 67 feet wide. These halls were always covered with timber roofs, sometimes ceiled half-way up, but as a rule open to the ridge, and known as open timber roofs. Similar roofs are also found in churches, where an abundant supply of timber suggested their employment or when on the score of expense the stone vault was beyond the resources of the builders. In the fifteenth century these open timber roofs are found in great abundance and variety, and the churches of Norfolk and Suffolk in particular still retain a number of beautiful features in the old hammer-beam roofs which cover the naves and aisles of their churches.

In the baronial hall the chief feature is the bow window, which was introduced about the end of the fourteenth century, and which became in later periods one of the chief characteristics of English Gothic architecture. The bow window generally lights the dais or raised portion at the end of the hall, where the lord of the mansion and his chief guests sat. It rises to the full height of the hall, and is subdivided by mullions and transoms, in respect of this latter feature (viz., the transom), differing from the church window, in which it rarely appears. One of the finest bow-windows is that which is found in Wolsey's great hall at Hampton Court, and one of the earliest is in the castle at Cowdray in Kent. The principal mansions or castles of the middle ages still preserved are Warwick Castle, (1377-92); Stokesay Castle, Shropshire; Haddon Hall, Derbyshire; and the colleges of Oxford and Cambridge, which still retain a large number of their ancient halls with kitchens and other offices appertaining thereto. The later phases of domestic Gothic architecture in England are generally known as Tudor work.

POLITICAL ECONOMY.—V.

(Continued from p. 278.)

DISTRIBUTION.—(B) THE LABOURER'S SHARE (*cont.*).

IT is true indeed that man, like other animals, lives on plants or on other animals. The means of subsistence are derived by man, directly or eventually (through the animals he eats), from plants, which multiply also. But they get their subsistence from the earth and air, and these are certainly fixed quantities. So that some day, in the absence of checks, population *must* encroach on the means of subsistence. This truth was seen in early Greece, where the land of each community was very limited. Weakly children were often put to death, and as long as there was any suitable land left within reach, numbers of colonies were sent out. Savages see it even more clearly, because they depend little if at all on agriculture and much on hunting, and it is often difficult to increase the supply of food obtained in the latter way; so that (as we have said) some tribes kill their superfluous female children. But it so happened that in Greece slavery was introduced early, and that there was always a large supply available (for various reasons, too many to state here) from barbarous countries. Thus it became cheaper to put slaves to work at agriculture and manufacture than to pay free labourers, and it was cheaper to import slaves than to raise them at home. Thus the free labourers were gradually crowded out by imported slaves, and the population seemed more likely to decrease than to increase. Still more was this the case in ancient Rome and Italy, and the decrease in their populations, as in that of Greece, was aided by the opening up of new countries to emigration—much of Western Asia Minor, North Africa, most of what is now France, Spain, and (latterly) Roumania—in all of which, however, manufacture was carried on by slaves, and in most of them, to a great extent, agriculture also; so that the free population of Rome, Greece, and Italy actually declined, and rewards were sometimes given (in the shape of exemption from taxation) by the Roman emperors to men with large families.

Famines, pestilences, and great wars too have checked the increase of population from the earliest times to the present day, and it was only when these became less frequent that the natural tendency of population to increase was observed. In ancient times, throughout the middle ages, and in the three centuries between their close and the French Revolution, when war was frequent and was the chief business of life to many of the governing classes, it seemed as if greater population in a country only meant greater fighting power, and as if there were no fear of its ever being too large. The actual occasion for the statement of the economic view of population was given by a book, Godwin's "Political Justice," written just after the French Revolution. This movement was essentially an uprising against the bad laws which kept the French agricultural population in a state of perpetual distress and want; and many people hoped that with the removal of such laws, in France and elsewhere, distress and want would cease. An Englishman, William Godwin (best known in connection with the life of the poet Shelley) sketched the happy state of society that he expected would result. This provoked Malthus, an English clergyman, to show, by an elaborate examination of history, that such a society as Godwin described would ultimately starve, because, with no want, no wars, and little disease, population would encroach on the means of subsistence. Malthus illustrated his theory thus. Population, we find by observation, doubles itself in a shorter or longer period. But food does not; its chief part, agricultural produce, could hardly be doubled or quadrupled, certainly not multiplied ten or twenty fold (unless, of course, as has happened since, new countries are constantly being opened up—and that process cannot go on for ever). Suppose, for the sake of argument, that population and food increased independently, and that the food existing now could be doubled, and could be increased at the same rate (which is very improbable) in each of the periods during which population was doubling itself. Then we should have:—

	Beginning of				
	First Period.	Second.	Third.	Fourth.	Fifth.
Population -	1	2	4	8	16
Food - -	1	2	3	4	5

Thus there would not be food enough at the end of the second period, and, however much surplus food or food-producing capacity there may be at first, it is clear that population must soon overtake it unless kept down by positive checks—war, famine, and disease—by poverty, or by the *prudential check* of refraining from marriage until one is likely to be able to support children.

Malthus' theory is sometimes met (by people who have not read his book) by simply saying that this has never happened yet. Malthus showed elaborately by an examination of the history of the world *why* it had never happened yet, viz., because checks had always been too powerful. But the positive checks are clearly declining in importance. Wars now, though more destructive, are far less frequent than formerly; disease is being overcome by discoveries in medicine, of which no one had the slightest conception till quite recently. Sanitation was all but unknown till the present century, and the invention of railways and steamers has abolished famine in civilised countries, except in small out-of-the way districts, where the means of communication are still bad. It has recently been calculated that the world, as a whole, will begin to be overcrowded about the end of the next century if population continues to increase at about its present rate. Will this produce the effect Malthus feared, scarcity and starvation?

One of the most learned of economists, Mr. Edward Atkinson, an American, gives this answer

("Distribution of Products," p. 22):—"First, no man yet knows the productive capacity of a single acre of land anywhere in respect of food. Second, the whole existing population of the globe, estimated at fourteen hundred million persons, could find comfortable standing room within the limits of a field ten miles square. In a field twenty miles square they could all be seated and by the use of telephones they could all be addressed by a single speaker. Third . . . we can raise grain enough on a small part of the territory of the United States to feed the world. . . . As yet, therefore, the doctrine of Malthus has found only a limited application, where some local or temporary congestion of human force has gathered. In this world there is somewhere and always enough." The only questions are (he continues) Where is it? and How to get it?

This, however, only puts off the evil day to an indefinitely remote date. More is to be hoped in the way of checking the increase of population from a higher standard of comfort and an increase of wants. It is at present the poorest classes who are most reckless in marrying and undertaking the responsibilities of a family; the fairly well-to-do do not marry until comparatively late in life, in order that they may have means to maintain their ordinary standard of comfort, to have the enjoyments they have been accustomed to have, and to give their children at least as good an education and as good chances in life as they have had themselves. In some cases no doubt this is carried too far, as in France, where population just now is almost stationary; but in the main, the simple rule of prudence not to marry till one can support a family is shown by political economy to be urgently necessary if the well-being of human society is to be maintained in the future.

Now it is important to notice that with the advance of civilisation real wages—the real reward of labour, the commodities and enjoyments that the labourer can purchase with his money wages—constantly tend to increase. This is not merely because there is more wealth in the world, because this alone might be counteracted by the increase of population; and it has been held, with some show of reason, that wages must be constantly falling to the minimum necessary for subsistence because of the increase of population. It is true that wages constantly *tend* to fall to this limit, but like a good many other tendencies in nature, this tendency is almost always checked. The waves of the sea constantly tend to a level, yet the winds and the tides and the ocean currents prevent the sea from being perfectly smooth at any time; more often than not it is very much the reverse. So this tendency—which some Socialist writers have called "the iron law of wages" because there seemed to them to be no escape from it—is generally counteracted, at least in great part, by the positive and preventive checks we have mentioned.

Besides, the improvements in machinery and processes of manufacture tend to make all goods except raw material constantly less and less costly; the competition of manufacturers brings down their prices, and the increase of demand often stimulates this competition. As the increase of demand may itself be due to a rise of wages, we have the surprising result that a rise of wages may help to make the world richer. Moreover, the competition between manufacturers tends to bring down their profits, and the increase of capital tends to make the use of capital cheaper, *i.e.* tends to bring down the interest or sum which the capitalist receives for lending it. So that, regarding the product of industry as divided between labourer and capitalist, we may say that as civilisation progresses the labourers, as a body, tend to get a larger proportion of the product absolutely and relatively, while the capitalists' and employers' share tends to diminish relatively—though it may increase absolutely because of the constant increase of wealth in the world.

(C) THE CAPITALIST'S SHARE—PROFITS WITH INTEREST.

The product of labour and capital in any trade is divided between labourer and capitalist in certain proportions, fixed by very complex conditions The chief of these are: the exchange value of the total product; the power of the labourers to make a good bargain for themselves; the share that the owner of the capital requires as compensation for its use and compensation for risk; while a further share goes to the responsible manager of the business as "earnings of management," whether the capital he uses is his own or not.

Interest in practice covers compensation for use and compensation for risk. Sometimes there is virtually no risk, and then we may say we have pure interest. Thus we may regard an investment in English Consols as perfectly safe. If £100 so invested produces 2¾ per cent., and £100 invested on mortgage on a cotton mill produces 4 per cent., the extra 1¼ per cent., or 25s. per annum, may be taken as representing a sort of insurance premium against the loss of the whole or part of the £100, should the cotton trade permanently fall off, or the machinery of the mill be superseded by new inventions. It is commonly said that "interest is the consideration paid for the use of money."

We should rather say for the use of wealth *as capital*. The lender might spend this wealth on present enjoyments; he prefers to abstain, and lend the wealth to someone who will use it productively; and as a reward for this abstinence he asks for a share of the product.

Being compensation for the use of capital, interest will be determined partly by the supply of capital available, relatively to the demand for it. Scarcity of capital will mean a high rate, while as capital becomes more plentiful the rate will tend to fall.

Now in early society and in the middle ages we find *all* interest or "usury" constantly denounced. The Jewish law forbade lending on interest except to strangers. "Giving money on usury" is classed in the Psalms of David with deceit and slander. Constantly in the middle ages, interest or "usury" was denounced by the Church. "Usury laws" were passed at various times in the history of England, first prohibiting interest altogether, then fixing the maximum rate. In modern times, however, business could not get on without the ability to borrow wealth —which, of course, would not be lent without some compensation, except as a pure matter of kindness or friendship.

The fact is that the ancient and mediæval writers had a wholly different state of things before them from that of our own day. In an early society foreign immigrants were the first borrowers—those "fugitive incomers" we have spoken of as victims of the blood feud. They could only live by getting land in some other community and borrowing cattle and seed corn to cultivate it. Being strangers in blood, the lenders did not mind making a hard bargain with them. But one of the community, as a rule, only borrowed when he had met with some misfortune—had lost his cattle or his crops. It was considered to be taking unfair advantage of his misfortunes to exact any reward for helping him out of them. And there was the same feeling throughout the middle ages in Europe, because borrowing was then almost always simply the resource of the distressed. But borrowing capital for commercial purposes is a very different matter. One man who has ability and knowledge but no capital sees a chance of producing wealth in manufacture or agriculture, or bringing goods from abroad to sell at home—all actions of great utility to society. He borrows the capital to do so from someone else, paying him for the use of it, and repaying himself out of his profits. The modern systems of banking and credit enable large masses of wealth which would otherwise be lying idle to be used in the production of further wealth, for the great benefit of society. And they tend to enable the men who have the greatest ability in organising and managing the production of wealth to use that ability by getting capital to work with. But before this can be seen commerce and manufacture must be considerably advanced.

Even when the advantage to society of borrowing and lending was partly seen, it was sometimes attempted to fix the maximum rate of interest by "usury laws." Thus in Henry VIII.'s reign this rate was fixed at 10 per cent.; in James I.'s at 8 per cent.; in Queen Anne's at 5 per cent. In fact, however, such laws have been found useless. A person may want money for a specially difficult enterprise (*e.g.*, to develop some quite new invention), which if it succeeds will profit society. If no one will lend him the money at the legal rate, he will probably try to get it secretly above the legal rate. But if the law says that the courts will not enforce the payment of interest above (say) 10 per cent., this greatly increases the risk of loss to the lender at a higher rate; and so he will exact a much higher rate than if there were no legal limitation.

The rate of interest in general clearly depends on "demand and supply." If there is plenty of wealth to lend and few people who want to borrow, the lenders will take a low rate rather than nothing. If there is an active competition for the use of wealth as capital, high rates will be offered. In practice, in England, the wealth that seeks permanent investment stands rather apart from the mass of wealth deposited with bankers, who, having constantly to repay portions of these deposits, can only lend (as a rule) for short periods. It is this latter wealth, waiting to be lent, with which "the Money Market" is concerned; and it is because both its amount and the number of people who wish to borrow it vary very widely at different times that the "Bank rate of discount" (that is to say, the rate of interest on loans for short periods) fluctuates greatly, and differs widely from the rate of interest on permanent investments.

This latter rate has fallen almost steadily throughout modern times. The market or average rates seem to have been slightly below the rates mentioned above as legal in different reigns. Early in this century the large loans raised by our Government to pay for the war with France sent it up to nearly 6 per cent. Since then it has gradually fallen, till now it is a little below 3 per cent. Of course, money lent for different trades will be lent at a different rate of interest, according to the supposed prospects of the trade; and some borrowers will be charged higher rates than others because "their credit is not so good," that is, their prospect of being able to repay is less. "Extra compensation for extra risk," in fact, comes in to increase the amounts paid in particular cases above the ordinary rate. The fall we see in history is clearly due to the increasing supply of capital, and to some extent to the diminution of risk in general caused by the better organisation of trade. In a *new country* interest is at first very high, because capital is scarce and there is much profitable use for it; and as lenders often hesitate to invest their money in a distant place, they exact a high rate for its use. Thus while the rate in England on first-class security is from 3 to 4 per cent., it is (or was not long ago) 7 or 8 per cent. in Kansas, and 15 per cent. in Tacoma, U.S. Of course, any great destruction of capital—by a foreign invasion, for instance—would send the rate of interest up again till the capital lost should be replaced.

As interest steadily tends to decline, some writers have supposed that we shall eventually reach a "stationary state," when capital will produce so little interest that there will be no inducement to save any more. Whether even then people would cease to save is doubtful, because they now save not merely to get interest on their capital but to provide means for their children, or their old age. Indeed, a fall in the rate of interest may even make people save more. If the average rate of interest on sound investments was 4 per cent. a man who wanted to leave his family £400 a year would have to save £10,000. If it fell to 2 per cent. he would have to save £20,000 to leave them the same income. The fall of interest, however, is checked by the opening up of new countries and new methods of production, which create more demand for capital, and by the occasional waste of capital in enterprises which prove unprofitable.

(D) EARNINGS OF MANAGEMENT.

Most English economists have assumed that the producer manages his own capital, and have lumped earnings of management and interest under "Profits," calling the former "wages for the labour of superintendence." But in modern trade the owner of the capital and the person who directs its use in production are often different people. The power to organise and manage a great business successfully is (comparatively) a rare power, and under the modern system of commercial credit any man who seems likely to possess it can easily borrow enough capital to commence business. It is the possession of this organising ability that has enabled many men—in some parts of England, Prof. Marshall says, more than half the employers of labour—to become employers of labour themselves, having begun as working men.

This man has no recognised economic name. "Manager" usually means a paid servant; "undertaker," used by Adam Smith, has a different meaning. Professor Walker, who first drew special attention to the importance in production of this class of persons, suggests the French word *entrepreneur*, meaning the person who undertakes the risk and work of carrying on the business.

Now, how are his receipts determined? Professor Walker has shown that it is in a way analogous to the mode of determining rent. There are a certain number of employers in any trade whose business ability is just sufficient to keep them in the trade. They struggle on; perhaps they own capital and just make the interest on it; more often they waste their own or other people's capital, go into bankruptcy, and start afresh to repeat the same course—trusting to luck to raise the profits of the trade generally for a time, and so give them a lift with the rest. Now, just as in the case of agricultural rent, the normal price of the goods produced in a trade will tend to be fixed by the cost of production of that portion of them which is produced at the greatest disadvantage; that is, which is produced by these "no-profit employers." The abler men manage better, and so could sell for less; but if they can get the same price as is given for the goods produced by the no-profit employers, why should they not take it? The extra profit they make thus is due to their ability to produce more cheaply. It is the surplus over cost of production on the margin of ability, just as agricultural rent is the surplus over cost of production on the margin of cultivation. Concisely we may call it "rent of ability."

Now, the more "no-profit employers" there are, the severer will be the competition in the trade, and the greater, consequently, will be the disadvantage at which they produce. The greater, therefore, will be the price of the product, and the greater the profits, or "rent of ability," of the abler employers.

GREEK.—XVIII.

[*Continued from p.* 273.]

THE PRESENT AND IMPERFECT ACTIVE OF CONTRACTED VERBS IN *-όω*.

VOCABULARY.

Ἀμαυρόω, I waste away, darken.

Ἀμέλεια, carelessness, disregard.

Ἀνθρώπινος, *-η*, *-ον*, human.

Ἀποῤῥοή, *-ῆς*, *ἡ*, outflow, source.

Ἐξισόω, I make equal (*ἴσος*, equal).

Ζητέω, I seek.

Ζηλόω, I desire, strive after.

Θεῖος, *-α*, *-ον*, divine.

Κοινωνία, *-ας*, *ἡ*, community, participation,

communion (*κοινός*, common).
Λιμός, -οῦ, ὁ, hunger.
Ὀρθόω, I put upright, restore (*ὀρθός*, straight, upright).
Ὅσπερ, ἥπερ, ὅπερ, who, which.
Συνεξομοιόω, I make like, compare (*σύν, ἐξ, and ὅμοιος*, like).
Τυφλόω, I make blind (*τυφλός*, blind).
Χαλεπῶς, hardly, with difficulty.

EXERCISE 93.

Translate into English .—

1. *Τὸ ἀληθὲς κάλλος, ὅπερ ἐκ θείας κοινωνίας ἔχει τὴν ἀποῤῥοήν, οὔτε πόνος ἢ λιμὸς ἢ ἀμέλειά τις, οὔτε ὁ χρόνος ἀμαυροῖ.* 2. *Αἱ φιλίαι τὰ ἔθη ζητοῦσι συνεξομοιοῦν.* 3. *Χαλεπῶς ἂν ταῖς τῶν ἀγαθῶν ἀρεταῖς ἐξισοίης τοὺς ἐπαίνους.* 4. *Ζήλου, ὦ παῖ, τοὺς ἐσθλοὺς καὶ σώφρονας ἄνδρας.* 5. *Ἡ τύχη πόλλους κακῶς πράττοντας ὀρθοῖ.* 6. *Πλῆθος κακῶν τὴν ἀνθηρωπίνν ζωὴν ἀμαυροῖ.* 7. *Οἱ νεανίαι τὴν σοφίαν ζηλοῖεν.*

EXERCISE 94.

Translate into Greek :—

1. Thou wastest away thy strength. 2. He wastes away his strength. 3. O that boys would seek for learning. 4. Riches blind men. 5. He was freeing the captives. 6. They free their children. 7. Thou wast freeing thy father, a captive. 8. He restores the bad citizens. 9. Disregard of life blinds the foolish. 10. They two blinded their friends.

THE PRESENT AND IMPERFECT MIDDLE OR PASSIVE OF CONTRACTED VERBS IN *-αω*.

VOCABULARY.

Ἀδυνατέω, I am powerless.
Ἀκροάομαι (with gen.), I hear, listen.
Ἡμερόδρομος, -ου, ὁ, a day-runner, a courier.
Μακάριος, -α, ον, happy.
Μηχανάομαι (Latin *machĭna*, our *machine*), I construct, devise.
Ὑπόδημα, -ἄτος, τὸ, a sandal, a shoe.
Χράομαι (Latin *utor*, with dat.), I use.

EXERCISE 95.

Translate into English :—

1. *Ὅταν ἀδυνατῇς τῷ πλούτῳ χρῆσθαι, τί διαφέρεις τοῦ πένητος;* 2. *Εὔνους λόγος λύπην ἰᾶται.* 3. *Τιμώμενοι πάντες ἥδονται βρότοι.* 4. *Οἱ ἄνθρωποι πολλὰ μηχανῶνται.* 5. *Μακάριός ἐστιν ὅστις οὐσίαν καὶ νοῦν ἔχει, χρῆται γὰρ καλῶς.* 6. *Ὁ ἀγαθὸς ὑπὸ πάντων τιμᾶται.* 7. *Οἱ ἡμερόδρομοι οὐκ ἐχρῶντο ὑποδήμασιν ἐν ταῖς ὁδοῖς.*

EXERCISE 96.

Translate into Greek :—

1. Thou didst hear. 2. They were hearing. 3. He was hearing. 4. He hears. 5. They devise. 6. They devised. 7. He uses. 8. You two use. 9. They use. 10. You were using. 11. He was using. 12. They were using. 13. Thou art unable to use thy substance wisely. 14. Happy are those who use their substance wisely.

THE PRESENT AND IMPERFECT MIDDLE OR PASSIVE OF CONTRACTED VERBS IN *-εω*.

VOCABULARY.

Ἀδικέω, I act unjustly, I do an injury.
Αἰδέομαι, I am ashamed, I reverence.
Ἀπιστέω, I believe not, trust not; *passive*, find no credit.
Ἀπόλυσις, -εως, ἡ, a solution, dissolution, freeing, termination.
Δέομαι, I need, require.
Ἕλλην, -ηνος, ὁ, a Hellene, a Greek.
Ἔτος, ἔτους, τό, a year.
Ἰσχυρός, -ά, -όν, strong.
Καταφρονέω, I look down on, I despise; *pass.* I am despised.
Μισέω, I hate.
Ὅπως, so that [takes a subj. with the principal tenses, and an opt. with the historic; also the future indicative after verbs denoting *care*].
Πλήσιος, -α, -ον, near; *οἱ πλήσιον*, the near, your neighbours *or* relatives.
Πολιορκέω, I besiege.
Τροία, -ας, ἡ, Troy.
Φοβέω, I frighten; *mid.* I fear.

EXERCISE 97.

Translate into English :—

1. *Τὸν ἀγαθὸν ἄνδρα ποιοῦ ἑταῖρον.* 2. *Τὸν ἰσχυρὸν δεῖ πρᾶον εἶναι ὅπως οἱ πλήσιον αἰδῶνται μᾶλλον ἢ φοβῶνται.* 3. *Ἀπιστοῦνται οἱ λάλοι, κἂν ἀληθεύωσιν.* 4. *Οἱ Πέρσαι ὑπὸ τῶν Ἑλλήνων ἐμισοῦντο καὶ κατεφρονοῦντο.* 5. *Ὁ μηδὲν ἀδικῶν οὐδενὸς δεῖται νόμου.* 6. *Τροία δέκα ἔτη ὑπὸ τῶν Ἑλλήνων ἐπολιορκεῖτο.* 7. *Μηδεὶς φοβείσθω θάνατον, ἀπόλυσιν κακῶν.*

N.B.—**Δέκα ἔτη**, *for ten years.* Duration of time in Greek, as in Latin, is put in the accusative.

EXERCISE 98.

Translate into Greek .—

1. Despise not each other. 2. They find no credit. 3. Thou despisest the bad. 4. He was despised (while) despising. 5. He does wrong. 6 Those who do wrong are wronged themselves. 7. They fear death, the end of evils. 8. The citizens fear lest the city may be besieged. 9. They speak the truth.

THE PRESENT AND IMPERFECT MIDDLE OR PASSIVE OF CONTRACTED VERBS IN *-οω*.

VOCABULARY.

Ἀλκή, -ῆς, ἡ, power, strength.
Γαυρόω, I make proud; *mid.* I am proud.
Δηλόω, I make clear, I manifest.
Ἐναντιόομαι (Latin *adversor*), I oppose, withstand.
Ζημιόω, I punish (*ζημία*, punishment).
Σάρξ, σαρκός, ἡ, flesh.

Μήτε — μήτε, nor — nor, neither — nor.

Ταπεινόω, I humble, humiliate.

Χειρόομαι (χείρ, the hand), I handle, compel, subdue.

EXERCISE 99.

Translate into English :—

1. *Δουλούμεθα τῇ σαρκὶ καὶ τοῖς πάθεσιν.* 2. *Τοὺς μὲν φίλους ἐλευθερῶμεν, τοὺς δὲ ἐχροὺς χειρώμεθα.* 3. *Μὴ γαυροῦ σοφίᾳ, μήτ' ἀλκῇ, μήτε πλούτῳ.* 4. *Ὁ ὑπερφρῶν ταπεινοῖτο.* 5. *Οἱ τοῖς ἀγαθοῖς ἐναντιούμενοι ἄξιοί εἰσι ζημιοῦσθαι.* 6. *Οἱ στρατιῶται ὑπὸ τῶν βαρβάρων ἐδουλοῦντο.* 7. *Πάντες κακοὶ ζημιοῖντο.*

EXERCISE 100.

Translate into Greek :—

1. Bad men are enslaved to the flesh. 2. You free your enemies; they do not free their friends. 3. He is proud of (dat.) his substance. 4. The bad oppose the good, but the good are happy. 5. They were being punished. 6. They are (being) punished. 7. We were punished. 8. You were punished. 9 May he who is proud of his wealth be speedily humbled.

CONTRACTED VERBS WHICH, CONTRARY TO THE RULE, RETAIN THE SHORT VOWEL

As in some uncontracted pure verbs, so in some contracted pure verbs, the short characteristic vowel of the root remains in the derived tenses. Most of these irregular verbs take σ in the perfect middle or passive and in the first aorist passive, as well as in the tenses thence formed. This fact is indicated by the form "pass. with σ." They are the following :—

(1) -ἄω.

Γελάω, *I laugh*, fut. γελάσομαι, aor. ἐγέλᾰσα ; pass. with σ

Ἐλάω (commonly ἐλαύνω), *I drive*, fut. ἐλάσω (Attic ἐλῶ), aor. ἤλᾰσα.

Θλάω, *I squeeze*, fut. θλάσω, etc. ; pass. with σ.

Κλάω, *I break*, fut. κλάσω, etc. ; pass. with σ.

Χαλάω, *I relax, unbind*, fut. χαλάσω, etc. ; pass. with σ.

Δαμάω (commonly δαμάζω), *I tame* (Lat. *domo*), aor. ἐδάμᾰσα.

Περάω, *I carry over*, fut. περάσω, aor. ἐπέρᾰσα; but περάω, *I go over* (intrans.), fut. περάσω, aor. ἐπερᾱσα.

Σπάω, *I draw asunder* (*spasm*), fut. σπάσω, etc.; pass. with σ.

Σχάω, *I loosen, open*, fut. σχάσω, etc.

(2) -εω.

Αἰδέομαι, *I reverence*, fut. αἰδέσομαι, aor. ᾐδέσθην, perf. ᾔδεσμαι.

Ἀκέομαι, *I heal*, fut. ἀκέσομαι, aor. mid. ἠκεσάμην, perf. ἤκεσμαι.

Ἀλέω, *I grind*, fut. ἀλέσω (seldom ἀλῶ), perf. mid. or pass. ἀλήλεσμαι.

Ἀρκέω, *I suffice*, fut. ἀρκέσω, etc. ; pass. with σ.

Ἐμέω, *I vomit*, fut. ἐμέσω, etc., perf. act. ἐμήμεκα, perf. mid. or pass. ἐμήμεσμαι.

Ζέω, *I seethe, boil* (intrans.) ; pass with σ.

Ξέω, *I scrape ;* pass. with σ.

Τελέω, *I end*, fut. τελῶ ; pass. with σ.

Τρέω, *I tremble*, fut. τρέσω, etc. Verbal adj. τρε-σ-τός.

Χέω, *I pour*, 1 aor. ἔχεα, perf. κέχῠκα, perf. pass. κέχῠμαι, aor. ἐχῠ́θην.

(3) -οω.

Ἀρόω, *I plough*, fut. ἀρόσω, aor. ἤροσα, perf. mid. or pass. ἀρήρομαι, aor. pass. ἠρόθην.

The following in some tenses have the long vowel, in others the short one :—

Ἐπαινέω, *I praise*, fut. ἐπαινέσομαι, aor. ἐπῄνεσα, perf. ἐπῄνεκα, aor. pass. ἐπηνέθην, but perf. mid. or pass ἐπῄνημαι.

Αἱρέω, *I take*, aor. pass. ᾑρέθην ; otherwise η, as αἱρήσω, ᾕρηκα, ᾕρημαι

Δέω, *I bind*, δήσω, ἔδησα, ἐδησάμην, but δέδεκα, δέδεμαι, ἐδέθην ; fut pass δεθήσομαι, for which the third future, δεδήσομαι, is commonly used.

Καλέω, *I call*, fut. καλῶ, aor. ἐκάλεσα, but perf. κέκληκα, etc.

Ποθεω, *I long for*, ποθήσω, ποθήσομαι, ἐπόθησα and ἐπόθεσα, πεπόθηκα, πεπόθημαι, ἐποθέσθην.

Πονέω (Lat *laboro*), *I labour, work*, πονήσω ; but πονέσω, *I shall be in pain ;* πεπόνηκα in both meanings ; mid. πονεῖσθαι, *to be fatigued*, fut. πονήσομαι, etc.

MODELS —ACTIVE.

Tense	*Characteristic α.*	*Characteristic ε*	*Characteristic ο.*
Pres.	Σπ(ά ω)ῶ, *I draw apart.*	Τελ(έ-ω)ῶ, *I end.*	Ἀρ(ό-ω)ῶ, *I plough.*
Impf.	ἔσπ(α-ον)ων.	ἐτέλ(ε-ον)ουν.	ἦρ(ο-ον)ουν.
Fut.	σπάσω.	τελῶ.	ἀρόσω.
Aor.	ἔσπᾰσα.	ἐτέλεσα.	ἤροσα.
Perf.	ἔσπᾰκα.	τετέλεκα.	ἀρ-ήροκα.
Plup.	ἐσπᾰ́κη.	ἐτετελέκη.	ἀρ-ηρόκη.

MIDDLE.

Pres.	σπ(ά-ο)ῶ-μαι.	τελ(έ-ο)οῦ-μαι.	ἀρ(ό-ο)οῦ-μαι.
Impf.	ἐσπ(ά-ο)ώ-μην.	ἐτελ(έ-ο)οῦ-μην.	ἠρ(ό-ο)ού-μην.
Fut.	σπάσομαι.	τελοῦμαι.	ἀρόσομαι.
Aor.	ἐσπα-σά-μην.	ἐτελεσάμην.	ἠροσάμην.
Perf.	ἔσπα-σ-μαι.	τετέλεσμαι.	ἀρ-ήρομαι.
Plup.	ἐσπά-σ-μην.	ἐτετελέσμην.	ἀρ-ηρόμην.

PASSIVE.

Aor.	ἐσπάσθην.	ἐτελέσθην.	ἠρόθην.
Fut.	σπασθήσομαι.	τελεσθήσομαι.	ἀροθήσομαι.

Verbal adjectives : σπαστέος. τελεστέος. ἀροτέος.

The further flexions of *ἔσπασμαι, ἐσπάσμην, τετέλεσμαι, ἐτετελέσμην*, are like *κεκέλευσμαι, ἐκεκελεύσμην*, already spoken of.

The following contracted verbs take *σ* in the passive, though they lengthen the characteristic vowel in the tenses: namely—

Νέω, *I spin*, *νένησμαι* and *νένημαι*, but *ἐνήθην*.

Νέω, *I heap up*, *νένησμαι* and *νένημαι*, also *ἐνήσθην*.

Πλέω, *I sail*, *πλεύσομαι, ἔπλευσα, πέπλευκα, πέπλευσμαι, ἐπλεύσθην*.

Φρέω, only in compounds, as *ἐκφρέω*, *I carry out*, *ἐκφρήσω*.

Χόω, *I accumulate*, *χώσω*.

Χράω, *I give an oracular response*, *ἐχρησάμην*.

Χράομαι, *I use*, has in the perfect middle *κέχρημαι*, *I have used*, but in the aorist passive *ἐχρήσθην*, *I was used*.

On the contrary, *ἐλάω, αἰνέω, αἱρέω, δέω*, and *ἀρόω* do not take the *σ*, though the characteristic vowel, in the perfect middle or passive and in the aorist passive, remains short.

VOCABULARY

Ἀδαήμων, -ον (gen. *-ονος*), inexperienced, unskilful.

Ἀκέομαι, I heal.

Ἀκολουθέω (with dat), I follow, come after.

Ἀνελευθερία, -ας, ἡ (*α* privative and *ἐλεύθερος*, free, generous; Latin *generosus*), illiberality (Latin *illiberalitas*), penuriousness, sordid spirit.

Ἐάω, I allow, permit.

Ἕλκος, -ους, τό, a wound (Lat. *ulcus*, Eng. *ulcer*).

Ἰατρός, -οῦ, ὁ, a physician.

Καίριος, -α, -ον, seasonable.

Κοσμέω, I adorn.

Κτάομαι, I gain, acquire; *κέκτημαι*, I possess

Λόγιος, -α, -ον, eloquent [*Eloquent* is from *loquor*, I speak, as *λόγιος* is from *λόγος*]

Μακεδών, -όνος, ὁ, a Macedonian.

Μηδέποτε, never [with the imper. and the subj. aor. used imperatively].

Ὀδυσσεύς, -έως, ὁ, Ulysses

Πενιχρός -ά, -όν, poor.

Σιωπηλός, -η, -ον, silent.

Σφάλλω, I trip up, I make totter.

Ὑψόω, I elevate.

Χηρόω, I bereave.

EXERCISE 101.

Translate into English —

1. *Οἱ περὶ Λεωνίδαν τριακόσιοι γενναίως μαχόμενοι ἐτελεύτησαν.* 2. *Πολλοὺς κακῶς πράττοντας ὤρθωσε τύχη.* 3. *Σφάλλει ἐκείνους οὓς ἂν ὑψώσῃ τύχη.* 4. *Ῥᾴδια πάντα Θεῷ τελέσαι.* 5. *Μηδέποτε κρίνειν ἀδαήμονας ἄνδρας ἐάσῃς.* 6. *Ὁ ποιητὴς τὸν λογιώτατον Ὀδυσσέα σιωπηλότατον πεποίηκεν.* 7. *Οἱ ἀγαθοὶ ἄνδρες πατρίδα κοσμήσουσιν.* 8. *Πολλοὶ κεκτημένοι πολλὰ οὐ χρῶνται δι' ἀνελευθερίαν.* 9. *Οἱ ἡμεροδρόμοι οὐκ ἐχρῶντο ὑποδήμασιν ἐν τοῖς ὁδοῖς.* 10. *Οἱ ἰατροὶ τὰ ἕλκη ἀκέσονται.* 11. *Ἡ γλῶττα σιγὴν καιρίαν κεκτημένη καὶ γέροντι καὶ νέῳ τιμὴν φέρει.* 12. *Οὐδεὶς ἔπαινον ἡδοναῖς ἐκτήσατο.*

Note.—*Οἱ περὶ Λεωνίδαν*, lit. *those around Leonidas* (*i.e.*, Leonidas and his warriors).

EXERCISE 102.

Translate into Greek:—

1. The good love and honour the good. 2. Noble youths will follow virtue. 3. Alexander, the king of the Macedonians, conquered Darius, the king of the Persians. 4. The citizens accounted the general worthy of great honour. 5. The war has bereaved the city of many citizens. 6. The enemy were conquered. 7. The physicians healed the wound. 8. No one will gain praise by enjoyments. 9. All things have been well ended.

KEY TO EXERCISES.

Ex. 89.—1. Appearances often deceive the mind. 2. Let not gain conquer thee. 3 I love virtue. 4. Often even a wicked man conquers a good man 5. Good men love virtue. 6. Many men die in the flower of their age. 7. Either be silent, or speak better things. 8 It is necessary for all men to die. 9. The mind sees and the mind hears 10. Let us rush bravely against the enemy, soldiers. 11. Many eat before they are hungry, and drink before they are thirsty 12. Fortune is no ally to the idle (*those who do nothing*). 13. Pericles was thundering and lightning, and putting Greece into confusion. 14. Would that all children would love their parents

Ex. 90. — 1. Ἐξαπατᾷς. 2. Ἐξαπατᾷ. 3. Ἐξηπάτα. 4. Ἐξαπατᾶτον. 5 Ἐξαπατῶσι. 6 Ἐνίκων. 7. Ἐνικῶμεν. 8. Ὁ στρατηγος νικᾷ παντας τους πολεμίους. 9. Πεινῶ. 10. Διψῶμεν. 11. Πεινωσι. 12. Οι συμμαχοι πεινῶσι. 13. Ἀστραπτᾷ. 14 Βροντᾷ 15. Την πόλιν συνεκύκας 16 Οἱ ἀγαθοὶ παῖδες τοὺς γονεας ἀγαπῶσι. 17 Ὁ παῖς την μήτερα ἀγαπᾷ. 18. Σὺ πάντας ἀγαπᾷς 19 Ἐκεῖνοι σὲ ὁρῶσι.

Ex. 91.—1. A wicked man is unfortunate, even though he prosper. 2. The best life is if you are master of your mind. 3. It is more becoming to be silent than to speak. 4. Think that God sees whatever you do. 5. A friend labouring with a friend labours for himself. 6. Let not mortal men think above the gods. 7. Let not him who is especially prosperous be haughty 8 One who is in misfortune should never despair, but expect better things. 9. God assists him who labours. 10. Practise justice in word and deed.

Ex 92 – 1. Δυστυχεῖ. 2 Εὐτυχοῦσιν. 3. Εὐτύχουν ἀλλ' οὐκ εὐδαιμόνουν 4. Δυστυχεῖς 5. Κράτει τοῦ θυμοῦ. 6. Φίλοι φιλοις συμπονοῦσι 7. Μη θνητὸς ἄνθρωπος ὑπὲρ θεοὺς φρονείτω. 8. Ἀθυμοῦσιν ὅταν κακῶς πράττωσι. 9. Ἀθυμεῖτε. 10. Ἥδομαι. 11 Ὁ παῖς τὸ σῶμα ἠμέλει. 12. Τοὺς τὴν δικαιοσύνην ἀσκοῦντας ἐπαινει ὁ σοφός.

APPLIED MECHANICS.—XIII.

[*Continued from p. 282.*]

STRENGTH OF MATERIALS—TERMS "STRESS" AND "STRAIN" DEFINED—SIMPLE TENSILE AND COMPRESSIVE STRESSES — HOOKE'S LAW — ELEMENTARY RULES—EXAMPLES.

"STRENGTH of materials" is the name given to the subject which deals with those questions involving the proper size and shape to be given to various parts of structures, the material of which those parts are composed, and loads to which they are subjected, being known. The relations between load and *deformation*, or change of shape, form the central facts or laws of this part of applied mechanics; indeed, we are here concerned chiefly with the laws of "stress" and "strain" of various kinds.

"Stress" is the mutual action believed to take place between two bodies in contact, or between the particles of a body subjected to load. For instance, if we suspend a heavy weight from a piece of wire fastened to the ceiling, it is evident that across any imaginary interface or cross-section the particles must act in such a way as to balance the pull of the load. This action we may image to ourselves as a mutual pull between the particles on the two sides of the section. Stress is generally measured in terms of applied force, and expressed as the *force per unit area* of cross-section, in such a case as that of a piece of material subjected to pull. The stress in this case is *tensile* stress.

A short pillar supporting a load is subjected to stress of a similar kind if the load acts perfectly in the axis of the pillar; the particles in this case, however, may be supposed to *push* instead of pull. This is termed *compressive* stress.

A third kind of stress is that due to a *tangential* force. The particles in this case are subjected to a mutual sliding action; this is called *shear* stress, and the resulting action is termed *shearing*. A plate of iron whilst being shorn in the shearing-machine is subjected to this stress. The only other stress to which we shall refer is that experienced by a body which is subjected to a uniform pressure, of the nature of fluid pressure, all over its surface. A small block of material immersed in the water in an hydraulic press has this kind of stress. It may be called *hydrostatic*, or volumetric, stress.

Each of the stresses here referred to is, in an elastic solid—meaning thereby a solid which, when subjected to stress within certain limits, returns again to its original shape when the stress is withdrawn—accompanied by a certain change of shape or volume. This change of shape, or deformation, is termed *strain*. Tensile stress is accompanied by tensile strain, and the body increases in length in the direction of the stress. Compressive stress involves compressive strain, or shortening. Shear stress involves shear strain, or distortion of a peculiar kind, which may be illustrated in a way to which we shall presently refer; and hydrostatic stress is accompanied by change of volume, or corresponding volumetric strain. Remember, then, that stress has reference to *load*, and strain to *deformation*. It is very important to observe these distinctions, as the terms are somewhat loosely used by many practical engineers. Stresses are usually expressed in *pounds of force per square inch of section*, strain being a mere *ratio*.

The methods of estimating the strain in the various cases will now be explained. For instance, in the wire referred to as being subjected to tensile stress and strain, the *strain* is measured by the *ratio of the increase of length to the original length* of the specimen, or it is the *fractional* elongation of that portion of the specimen considered.

Compressive strain is measured in a similar way, substituting *decrease* for increase of length.

The way in which shear strain is measured will be best understood by reference to Fig. 75, in which a small prism of stuff is acted on by forces as shown, the result being the production of shear strain, which is measured by the little angle (in radians) between the old position X Y′ of one side and its new position X Y. Since this angle is very small for ordinary forces and materials, its magnitude may be taken as $\frac{\text{Y Y}'}{\text{Y}'\text{X}}$; and if we call the side X x the *fixed* side of the prism, the ratio which measures the shear strain is *the amount of motion of a particle in a direction parallel to the fixed side, divided by its distance from that side*. This is, as before, a mere ratio, and we may adopt any units we please for its measurement if the *same* units are employed for both terms of the ratio.

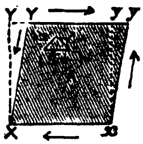


Fig. 75.

Volumetric strain has reference to change of bulk; and if produced by *increase* of hydrostatic pressure, it is measured by the *ratio of the diminution of volume to the original volume*. If the pressure diminishes, substitute *increase* for diminution in volume.

HOOKE'S LAW.

Hooke, about the year 1676, first enunciated his celebrated law, deduced from certain experimental observations—the law being that, within the limits of stress for which the material is perfectly elastic,

Stress is proportional to Strain.

If we apply Hooke's law to each of the kinds of stress and strain we have been dealing with, it tells us that in each case

Stress = strain multiplied by a certain coefficient or multiplier.

For tensile or compressive stress and strain, the rule becomes—

$$\text{Stress} = \text{E} \times \text{strain},$$

where E is a coefficient or modulus, generally called "Young's modulus of elasticity." It is different for different materials, but the same for tension and compression in most materials.

For shear stress and strain the law is—

$$\text{Stress} = N \times \text{strain},$$

where N is the "modulus of rigidity," or modulus of torsional elasticity of the stuff.

For the remaining kind of stress and strain referred to the law is—

$$\text{Stress} = K \times \text{strain},$$

where K is the "modulus of cubic compressibility."

All these moduli are generally expressed in lb. per square inch; in other words, the modulus is really that stress which would produce unit strain if the stuff remained elastic. For instance, in the case of a tie-rod the modulus E is that tensile stress which would make the elongation *equal* to the original length if we can imagine any material as being elastic for such a high stress. Of the three moduli, that of most importance in engineering calculations is Young's modulus. The following table gives average values of the moduli for a few materials:—

MODULI OF ELASTICITY

Material.	E	N	K
Iron, cast . .	17,000,000	6,300,000	14,000,000
„ wrought	27,000,000 to 29,000,000	10,500,000	20,000,000
Steel, mild . .	30,000,000	11,000,000	—
„ tempered .	36,000,000	13,000,000	26,000,000
Brass . . .	12 000,000	3,500,000	—
Copper . . .	15,000,000	5,000,000	24,000,000
Phosphor bronze .	13,500,000	5,400,000	—
Aluminum bronze	14,800,000	—	—
Gun metal . .	11,500,000	—	—
Wood, yellow pine	1,400,000	90,000	—
„ pitch pine	2,000,000	—	—
„ oak . .	1,800,000	82,000	—
Water . . .	—	—	300,000

ULTIMATE AND PROOF STRESSES.

The *ultimate stress*, or strength, of any material is the intensity of stress, of any given kind, required to produce fracture. It is estimated as if the section of the material remained of the same size up to the breaking, which is not the case, as the section, in the case of tensile stress, for instance, usually diminishes before fracture takes place.

The *proof stress*, or elastic strength, of any material is the greatest stress the material will bear repeatedly without taking a "permanent set," or without permanently changing in shape.

The *working stress* is that stress which is considered permissible in practice, and is usually found by dividing the ultimate or breaking stress by a number called the *factor of safety*. It appears, however, that the practice of French engineers of allowing as working stress a certain fraction of the *elastic* stress, is more consistent with theory. The factor of safety in both cases must be determined by experience.

Our knowledge of the ultimate and proof stresses of various materials, and of their behaviour under load, is mainly due to experiments which have been carried out by the aid of testing-machines designed for the particular purpose. Our space does not admit of a very detailed description of any of these, or of the various methods of applying and measuring the loads or stresses and the corresponding strains. The form of testing-machine for such materials as iron and steel most in favour in this country acts somewhat on the principle of the machine which will now be described. In Fig. 76 a single-lever testing-machine of the type most used for testing iron and steel in large ironworks, and also in the laboratories of engineering and technical colleges, is shown. The student will have no difficulty in understanding the action of the machine. The specimen *a* is connected by proper gripping arrangements *g g* at one end to the short arm of a strong lever L, the fulcrum of which is nearly over the centre of the strong central support, and at the other to a powerful cross-head connected with the ram of an hydraulic press, the pump of which is worked by a belt through spur-gearing and a pair of screws, which arrangement steadily presses the water without pulsation out of the pump-barrel into the straining cylinder. The moment of the pull in the specimen is balanced by the moment of the movable weight W, which is rolled along the lever by a screw and worm-wheel (not shown), the screw being worked by the spur-wheels *m n* driven through the bevel-wheels B, either by steam power from the pulley P or by the hand-wheel H. The lever L is continued in the direction of *m*, and the movable weight starts at its zero position from a point on this end of the lever, at which it balances the excess weight of the longer end of the lever, an upright standard R being provided to prevent too great a descent of that end of the lever when the specimen breaks. The machine is here shown arranged for tensile tests, as its action is then more easily understood, but it can also be arranged for compressive and bending tests.

This machine has been supplied by the makers, Messrs. Joshua Buckton and Co., of Leeds, to many large ironworks and engineering college laboratories: among others, to the Central Institution of the City and Guilds of London Institute; in that case, a 100-ton machine—*i.e.*, a machine capable of applying a pull equal to the weight of 100 tons to the specimen. The various methods of measuring the strains corresponding to different applied loads we need not here enter into; that adopted by Professor Unwin in connection with the 100-ton machine just referred to is a semi-automatic recording method.*

STRESS-STRAIN DIAGRAMS.

The curve connecting stress and strain is found by experiment to be a fairly straight line for loads not exceeding the elastic limit, especially in the case of such materials as wrought-iron and steel. Such a curve as that shown in Fig. 77 would be obtained in testing these materials, especially if the curve be automatically drawn by a suitable autographic recording-apparatus.

It will be seen that up to a point A the line is almost exactly straight, showing agreement with Hooke's law. Between A and B there is a slight curvature, and at B there is (especially for hammered or rolled specimens) a peculiar deflection in the curve; this has been called the "yield point," and is probably the record of a physical condition due to the hammering or rolling to which the specimen has been subjected. The maximum load is reached at C (which has been called the "plastic limit" by Professor Unwin), the specimen, if in tension, drawing out locally from B to C, and breaking at D. Diagrams like this have done a great deal to enlighten us as to the behaviour of materials under stress.

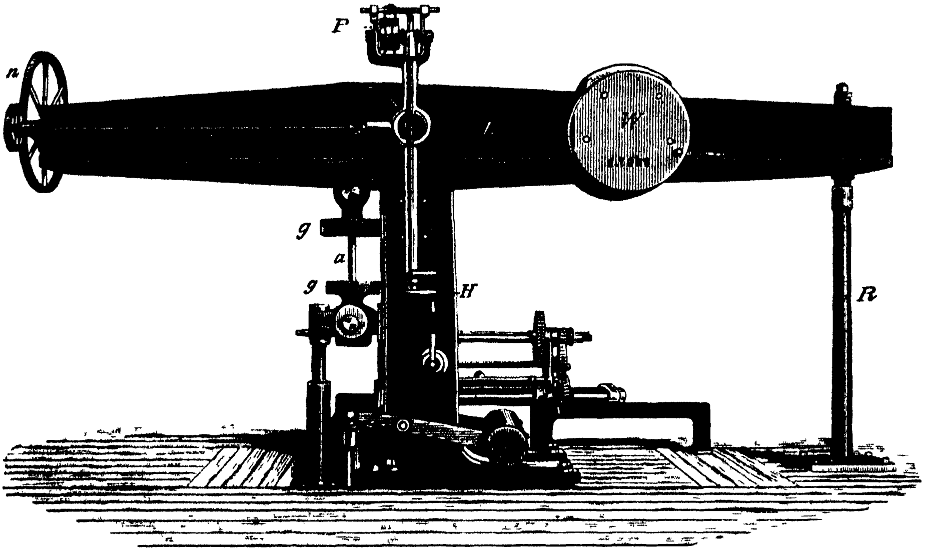


Fig. 76.

With the "fatigue" of materials we have not space, to deal, nor with such facts as the raising of the elastic limit by the application of a load slightly exceeding the old limit, nor the influence on the shape of the curve, of the time-rate of application of the load. In regard to the "fatigue" of metals, it has been shown by Sir W. Thomson that a wire supporting a weight, when kept vibrating with a circular reciprocating motion, showed increased sluggishness, due probably to increased internal viscosity, as time went on; but that, if allowed to

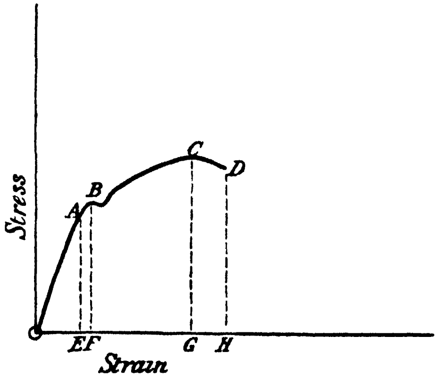


Fig. 77.

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* For further description of this method and valuable information on the subject, see "The Testing of Materials of Construction," by Prof. Unwin, F.R.S.

rest, its original elasticity was regained. Materials like iron and steel only stand a comparatively small stress if that stress *alternates*, say, from tension to compression.

By means of testing-machines of the types referred to, values of the ultimate and proof stresses of various useful materials have been obtained. The following table gives average values for some of the materials most in use in engineering construction. These values have been selected from various authorities; for the most part from Professor Ewing's article on "The Strength of Materials," in the *Encyclopædia Britannica*

ULTIMATE STRESSES (*Pounds per square inch*)

Material	Tensile	Compressive	Shearing
Cast iron	15 600	94,000	24,600
Wrought iron plates along the fibre	54,000	44,800	45,000 to 50,000
Wrought iron plates across the fibre	50,000		
Wrought iron bars	56,000		
,, wire	78,000	—	—
Steel plates, mild	67,000	—	About 50,000
Axle and rail steel	80 000	—	,, 60,000
Finest chrome and tungsten steels	100,000 to 180,000	—	—
Steel piano wire	300 000	—	—
Copper, cast	26 000	78 000	About same as tensile
,, rolled	35,000	—	
,, wire	62,000	—	
Brass	25 000	11 200	—
,, wire	50,000	—	—
Phosphor bronze	45 000	—	—
,, ,, wire	74 000 to 150,000	—	—
Manganese bronze	67,000		—
Timber—			
Yellow pine	3,350 to 7 500	5 500	—
Pitch pine	9 000	—	—
Oak	7 000 to 15,000	9,000	2,500

PRACTICAL ILLUSTRATIONS AND EXAMPLES

The student can very easily arrange a simple apparatus whereby the connection between tensile stress and strain may be illustrated Let him fasten one end of a piece of wire to a beam or other suitable support, and load the wire at the other end with a regularly increasing series of weights, observing the lengthening of the wire corresponding to each load by means of verniers Fig 78 shows a suitable arrangement It will be found that when the several values of load and the corresponding elongations are plotted on squared paper, a curve is obtained which is fairly straight for some distance from the origin, showing that within certain limits *lengthening is proportional to load*, which is really Hooke's law. The elongation should be measured by two verniers, fastened respectively at some distance from the ends of the wire, the length of wire between the verniers only being considered; the *difference* of the motions of the two verniers divided by this length will then be the strain.

The problem of designing a piece of any structure so as to resist compression is not so simple as if the stress were tensile In the case of a tie, the *of cross-section* is the all-important consideration, its shape not being of much importance. In the case of a strut, not only must the section be of sufficient *area*, it must also be of a suitable *shape* to prevent deflection or bending. The question occurs to one here why should a strut bend laterally? Well, if the strut were perfect and perfectly loaded it would *not* deflect till just on the point of breaking, when it would suddenly bend and break.

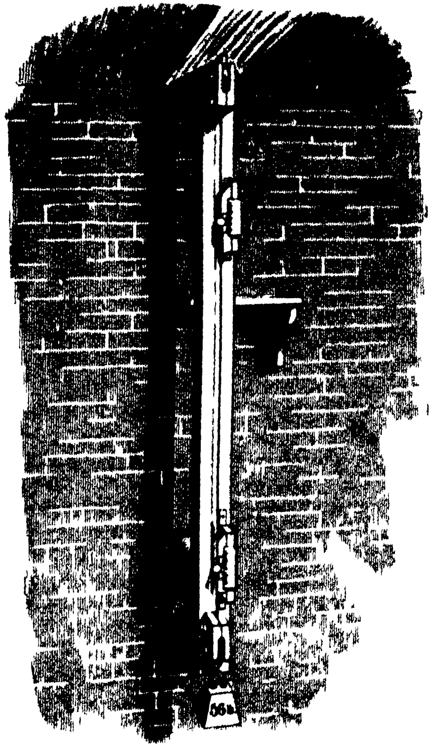

Fig 78.

But struts in practice are never perfect, either in homogeneity or in axiality of load, and hence we have a gradually increasing deflection as the load is increased.

If a tie is originally a little bent the load tends to straighten it; whereas if a strut has an initial deflection, the load *increases* this defect; in other words, a tie is in *stable* and a strut in *unstable* equilibrium. It is only when a strut is *short* in comparison to its lateral dimensions that its strength may with any degree of accuracy be calculated by the rules for simple compressive stress.

In the case of shear stress and strain, a rough illustration of what takes place may be arranged (as shown in Fig. 79) by fastening a prism of some yielding material like india-rubber to a table, and acting on one of its faces by a tangential force. In the figure, a rectangular block of india-rubber G F Z H is fastened to a table, and a board A B is attached to one edge with strong cement; the board being pulled by a horizontal force, approximate shear strain being produced if the length F G of the prism is great in comparison with its depth G H. The shear stress is estimated by dividing the total horizontal force (in this case the suspended weight) by the area of the india-rubber in square inches at the place where it touches the board. The shear strain is the corresponding motion Y Y′ divided by the distance Y′ X, both in the same units.

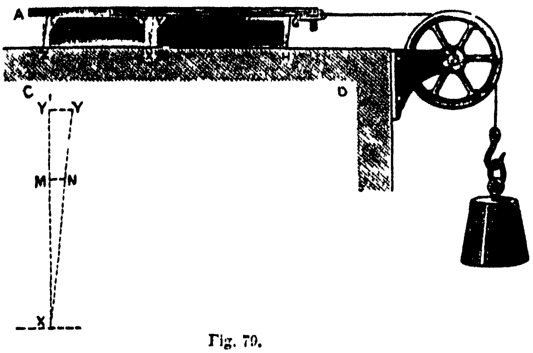

Fig. 79.

If corresponding values of shear stress and shear strain be plotted on squared paper, a fairly straight line is obtained, showing that up to a certain load Hooke's law is true. Part of the motion, however, is due to bending, and the experiment cannot be considered as more than a rough illustration of what really takes place in a material subjected to shearing forces.

No simple illustration of the laws of cubic compressibility can be arranged. With the piezometer (an apparatus described in most books on natural philosophy) experiments of this nature may be carried out. The practical bearing of the laws of stress and strain, which have been very briefly introduced to the reader's notice, will be shown in the following examples.

NUMERICAL EXAMPLES.

1. A wrought-iron bar used as a tie-rod has to withstand a pull of 20 tons; find the proper area of its cross-section from the limits of stress given in the table on p. 345, and using 5 as a factor of safety.

Referring to the table, the ultimate stress for wrought-iron bars is 56000 lb. per square inch; hence, the safe stress is $\frac{56000}{5}$, or 11200 lb. per square inch.

$$\frac{\text{Total load}}{\text{Area of section}} = \text{stress} = 11200,$$

$$\text{Or,}\quad \frac{20 \times 2240}{11200} = \text{area required.}$$

Hence the required area is 4 square inches.

2. If the tie-rod in the previous example is of circular section, find its diameter.

The area of a circle d inches in diameter is $\cdot 7854 \times d^2$ square inches; in this case, therefore,

$$4 = \cdot 7854 d^2,$$

$$\text{Or,}\quad \sqrt{\frac{4}{\cdot 7854}} = d, \text{ whence } d = 2\cdot 256 \text{ inches.}$$

Note —The following is a convenient rule for finding the diameter of a circle of which the *area* is given :—

$$d = 1\cdot 128\sqrt{A} = 1\tfrac{1}{8}\sqrt{A} \text{ nearly,}$$

where A is the area.

3. A weight of 60 lb. is suspended by a wrought-iron wire; find the diameter of the thinnest wire which can be used with safety, the factor of safety being as in Example 1. Stress as per table.

Answer, $d = \cdot 06$ inch.

4. Find the amount the last wire will elongate when loaded, its length being 20 feet and E = 29000000.

The stress is 15600 lb. per square inch.

$$\text{Stress} = \text{E} \times \text{strain},$$

$$\text{Or } 15600 = 29000000 \times \text{strain},$$

$$\text{Whence strain} = \frac{156}{29000} = \cdot 0005379.$$

Now strain is the fraction of its length by which the wire gets longer; in other words, every foot elongates ·0005379 of a foot, or 20 feet elongate ·0005379 × 20 of a foot,

Or ·0005379 × 240 of one inch = ·129 inch, the elongation required.

5. Find the elongation of a steel bar 2 inches square and 40 feet long, when subjected to a pull of 40 tons. E = 30000000. Answer, ·358 inch.

6. The diameter of the piston of a steam-engine is 12 inches, the diameter of its rod (which is of steel) $1\frac{3}{4}$ inches; if the space in the cylinder round the piston-rod is put in communication with a boiler

containing steam at a pressure of 80 lb. per square inch, find the lengthening of the piston-rod just before motion occurs. The length of the piston-rod is 5 feet. Answer, ·00736 inch.

7. Find the safe load on a circular iron rivet 1 inch in diameter, it being in "single shear"—*i.e.*, so fixed as to be likely to shear at *one* section only. The ultimate shear stress may be taken as 22 tons per square inch, and the factor of safety 5, used as before. Answer, 7740·8 lb.

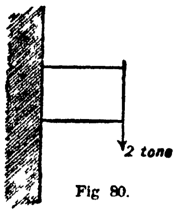

Fig 80.

8. A pine beam 3 inches broad and 11 inches deep projects 1 foot from a wall, into which it is firmly built, and bears a load of 2 tons at its outer end; find the deflection of that end, due to shearing. N = 90000.

Referring to Fig. 80, we may consider the load of 2 tons as acting uniformly over the end of the beam, which is 11 × 3 = 33 square inches in area. Hence shear stress $= \frac{2 \times 2240}{33} = 136$ lb. per square inch nearly. But shear stress = N × shear strain.

Let x inches be the deflection required, then $\frac{x}{12} =$ the shear strain;

$$\therefore\ 136 = N \times \frac{x}{12}, \text{ or } \frac{136 \times 12}{90000} = x;$$

from which $x = {·}018$ inch, the deflection required

9. The two halves of a flange coupling, which has to transmit 60 horse-power at 100 revolutions per minute, are fastened together by four wrought-iron bolts, the centre of each bolt being 6 inches from the centre of the shaft. Taking the same stress and factor as in Example 7, find the smallest sectional area which will be sufficient for each bolt, supposing the coupling to have only to transmit the power steadily, and not to be subjected to shocks.

Let a square inches = the required area. Then $a \times 9856$ is the greatest force each bolt will bear; and $a \times 9856 \times \frac{1}{2} = a \times 4928$ is the moment of this force about the centre of the shaft in pound-feet, and four times this is the total torque or turning moment.

But torque × 2π × No. of revolutions per minute ÷ 33000 = horse-power.

Hence,

$$\frac{a \times 4928 \times 4 \times 2 \times 3{·}1416 \times 100}{33000} = 60;$$

from which $a = {·}16$ of a square inch nearly.

10. Find the new volume which 1 cubic foot of water assumes after it has been subjected to a pressure of 3 tons per square inch in an hydraulic press. K = 300000. Answer, ·9776 cubic foot.

ITALIAN.—XII.

[*Continued from p.* 287.]

IRREGULAR VERBS OF THE SECOND CONJUGATION.

Verbs ending in *-ere* are of two sorts. The first have their present indefinite long, such as *bére*, *cadére*, etc.; the second short, such as *assórbere*, *conóscere*, etc.

I. IRREGULAR VERBS ENDING IN *-ére* LONG.

The irregular verb *potére*, to be able, is thus conjugated:—

INDEF. *Simple Tenses.* *Pres.* Potére, *to be able.*—*Pres. Gerund.* Potèndo, *being able.*—*Past Part.* Potúto, *been able.*——*Compound Tenses.*—*Past.* Avére potúto, *to have been able.*—*Past Gerund.* Avèndo potuto, *having been able.*

IND. *Pres.* Posso; puoi; può, puòte *or* pòte. Possiámo; potete; possono *or* ponno *Imp.* Potéva *or* potéa; potévi; potéva *or* potea. Poteváno; potevàte; potévano *or* potéano.—*Ind. Pret.* Potéi, potesti; potè. Potémmo; potéste; potérono, potéttero, potero *or* poter.—*Fut.* Potrò, potrái, potrà; potremo, potrete, potránno.—*Cond. Pres.* Potréi *or* potria; potresti; potrebbe *or* potria. Potrémmo; potréste; potrébbero, potriano *or* potrieno.

(*No Imperative*)

SUB. *Pres.* Che possa, che possa, che póssa; che possiámo, che possiate, che possano.—*Imp.* Che potéssi, che potéssi, che potesse; che potéssimo, che poteste, che potessero.

The irregular verb *sapére*, to know, is thus conjugated:—

INDEF. *Simple Tenses.*—*Pres.* Sapere, *to know.*—*Pres. Gerund.* Sapendo, *knowing* *Past Part.* Sapúto, *known.*——*Compound Tenses*—*Past.* Avére saputo, *to have known*—*Past Gerund.* Avèndo saputo, *having known.*

IND. *Pres.* So, sai, sa *or* sape; sappiámo, sapéte, sánno.—*Imp.* Sapéva *or* sapéa, sapévi, sapeva *or* sapéa; sapeváno, sapevate, sapévano *or* sapeáno.—*Ind. Pret.* Séppi, sapésti, seppe; sapemmo, sapéste, seppero *Fut.* Saprò, saprái, saprà; sapremo, saprete, sapranno.—*Cond. Pres.* Sapréi *or* sapria; saprésti; sapréble *or* sapria. Saprémmo; sapréste; saprébbero, sapriano, *or* saprieno.

IMP. Sáppi, sáppia; sappiamo, sappiáte, sáppiano.

SUB. *Pres.* Che sáppia, che sáppia, che sáppia; che sappiámo, che sappiáte, che sáppiano.—*Imp.* Che sapéssi, che sapéssi, che sapésse; che sapéssimo, che sapéste, che sapéssero.

After this example conjugate the following irregular verbs:—

Assapére, *to let one know.*	Risapére, *to know again.*
Antisapére, *to foresee.*	Strasapére, *to be too knowing.*

The irregular verb *sedére*, to sit down, is thus conjugated:—

INDEF. *Simple Tenses.*—*Pres.* Sedere, *to sit down*—*Pres. Gerund.* Sedèndo *or* seggèndo, *sitting down.*—*Past Part.* Sedúto, *sat down.*——*Compound Tenses.*—*Past.* Avére sedúto, *to have sat down.*—*Past Gerund.* Avèndo sedúto, *having sat down.*

IND. *Pres.* Siédo *or* séggo, siédi, siéde; sediámo *or* seggiámo, sedéte, siédono *or* séggono.—*Imp.* Sedéva *or* sedéa; sedevi; sedéva *or* sedéa. Sedevámo; sedeváte; sedévano, sedíeno, *or* sedéano.—*Ind. Pret.* Sedéi *or* sedétti; sedésti; sedè, sedétte, *or* sedéo. Sedémmo; sedéste; sedérono, sedéttero, *or* sedéro.—*Fut.* Sederò *or* sedrò, sederái, sederà; sederémo, sederéte, sederánno.—*Cond. Pres.* Sederéi, sedréi, *or* sedería; sederésti; sederèbbe. Sederémmo; sederéste; sederébbero.

Imp. Siédi, siéda or ségga; sediámo or seggiámo, sedéte, siédano or séggano.

Sub. *Pres.* Che siéda, ségga, or séggia; che siéda, ségga, séggia, or séggi; che siéda or ségga. Che sediámo or seggiámo; che sediáte or seggiate; che siédano, séggano, or séggiano.—*Imp.* Che sedéssi, che sedéssi, che sedésse; che sedéssimo, che sedéste, che sedessero.

After this example conjugate the following irregular verbs:—

Possedére, *to possess.*
Presedére, *to preside.*
Risedére, *to reside.*
Soprassedére, *to supersede.*

The irregular verb *tenére*, to hold, is thus conjugated:—

Indef. *Simple Tenses.—Pres.* Tenére, *to hold.—Pres. Gerund.* Tenéndo, *holding.—Past Part.* Tenúto, *held.——Compound Tenses.—Past.* Avére tenúto, *to have held.—Past Gerund.* Avéndo tenúto, *having held.*

Ind. *Pres.* Téngo, tiéni, tiéne; teniámo, tenéte, téngono.—*Imp.* Tenéva or tenéa; tenévi; tenéva, tenéa, or tenía. Tenevámo; tenevàte; tenévano or tenéano.—*Ind. Pret.* Ténni, tenésti, ténne; tenémmo, tenéste, ténnero—*Fut.* Terrò, terrài, terrà; terrémo, terréte, terránno.—*Cond. Pres.* Terréi or terría, terrésti, terrébbe or terría; terrémmo, terréste, terrébbero or terríano.

Imp. Tiéni, ténga; teniámo, teniáte, téngano.

Sub. *Pres.* Che ténga, che ténga, che ténga; che teniámo, che teniáte, che téngano.—*Imp.* Che tenéssi, che tenéssi, che tenésse; che tenéssimo, che tenéste, che tenéssero.

After this example conjugate the following irregular verbs:—

Appartenére, *to belong.*
Astenérsi, *to abstain.*
Attenére, *to attain.*
Contenere, *to refrain* or *contain.*
Detenere, *to detain.*
Intertenére, *to detain.*
Mantenére, *to maintain.*
Ottenére, *to obtain.*
Appartenére, *to belong.*
Rattenére, *to stop.*
Ritenére, *to retain.*
Soprattenére, *to retain.*
Sostenére, *to support.*
Trattenére, *to entertain.*

The irregular verb *vedére*, to see, is thus conjugated:—

Indef. *Simple Tenses.—Pres.* Vedére, *to see.—Pres. Gerund.* Vedéndo or veggéndo, *seeing.—Past Part.* Vedúto or vísto, *seen.——Compound Tenses.—Past.* Avére vedúto, *to have seen.—Past Gerund.* Avéndo vedúto, *having seen.*

Ind. *Pres.* Védo, véggo, or véggio; védi or ve'; véde. Vediámo or veggiámo; vedéte; védono, véggono, or veggiono.—*Imp.* Vedéva or vedéa, vedévi, vedéva or vedéa; vedevámo, vedeváte, vedévano.—*Ind. Pret.* Vídi, vedésti, víde; vedémmo, vedéste, videro.—*Fut.* Vedrò, vedrài, vedrà; vedrémo, vedréte, vedránno.—*Cond. Pres.* Vedréi or vedría, vedrésti, vedrébbe or vedria; vedrémmo, vedréste, vedrébbero or vedríano.

Imp. Védi or ve'; véda, végga, or véggia. Vediámo or veggiámo; vedéte; védano, véggano, or véggiano.

Sub. *Pres.* Che véda, végga, or véggia; che véda, végga, véggia, or véggi; che véda, végga, or véggia. Che vediámo or veggiámo; che vediáte or veggiate; che védano, véggano, or véggiano.—*Imp.* Che vedéssi, che vedéssi, che vedésse; che vedéssimo, che vedeste, che vedéssero.

After this example conjugate the following irregular verbs:—

Antivedére, *to foresee.*
Avvedérsi, *to perceive.*
Disvedére, *to neglect.*
Divedére, *to share.*
Malvedére, *to look at with an evil eye.*
Prevedére, *to foresee.*
Provvedere, *to provide.*
Ravvedérsi, *to amend.*
Rivedére, *to see again.*
Sopravvedére, *to observe attentively.*
Sprovvedére, *to leave destitute.*
Stravedére, *to see much.*
Travedére, *to see double.*

The irregular verb *volére*, to be willing, is thus conjugated:—

Indef. *Simple Tenses.—Pres.* Volére, *to be willing.—Pres. Gerund.* Voléndo, *being willing.—Past Part.* Volúto, *been willing.——Compound Tenses.—Past.* Avére volúto, *to have been willing.—Past Gerund.* Avéndo volúto, *having been willing.*

Ind. *Pres.* Vóglio or vo'; vuói, vuóli, or vuo'; vuóle. Vogliámo; voléte; vógliono.—*Imp.* Voléva or voléa; volévi or voléi; voléva, voléa, or volía. Volevámo; voleváte; volévano or voléano.—*Ind. Pret.* Vólli, volésti, vólle; volémmo, voléste, vóllero.—*Fut.* Vorrò, vorrài, vorrà; vorrémo, vorréte, vorránno.—*Cond. Pres.* Vorréi or vorría; vorrésti; vorrébbe or vorría. Vorrémmo; vorréste; vorrébbero, vorríano, or vorríeno.

Imp. Vógli, vóglia; vogliámo, vogliáte, vógliano.

Sub. *Pres.* Che vóglia, che vóglia, che vóglia; che vogliámo, che vogliáte, che vógliano.—*Imp.* Che voléssi, che voléssi, che volésse; che voléssimo, che voléste, che voléssero.

II. IRREGULAR VERBS ENDING IN *-ere* SHORT.

1. *Verbs ending in* -CERE.

The irregular verb *créscere*, to grow, is thus conjugated:—

Indef. *Simple Tenses.—Pres.* Créscere, *to grow.—Pres. Gerund.* Crescéndo, *growing.—Past Part.* Cresciúto, *grown.——Compound Tenses.—Past.* Éssere cresciúto, *to have grown.—Past Gerund.* Essendo cresciuto, *having grown.*

Ind. *Pres.* Cresco, crésci, cresce; cresciámo, crescéte, créscono.—*Imp.* Crescéva or crescéa, crescévi, crescéva or crescea; crescevámo, cresceváte, crescévano or crescéano.—*Ind. Pret.* Crébbi; crescésti; crébbe. Crescémmo; crescéste; crébbero, crescéro, or crescér.—*Fut.* Crescerò, crescerài, crescerà; crescerémo, cresceréte, crescerànno.—*Cond. Pres.* Crescerèi or cresceria, crescerésti, crescerébbe or cresceria; crescerémmo, crescereste, crescerébbero or cresceríano.

Imp. Crésci, crésca; cresciámo, crescéte, créscano.

Sub. *Pres.* Che crésca, che crésca, che crésca; che cresciámo, che cresciáte, che crescano—*Imp.* Che crescéssi, che crescéssi, che crescésse; che crescéssimo, che crescéste, che crescéssero.

After this example conjugate the following irregular verbs:—

Accréscere, *to increase.*
Decréscere, *to decrease.*
Discréscere, *to decrease.*
Incréscere, *to be tired.*
Ricréscere, *to grow again.*
Riaccréscere, *to increase.*
Rincréscere, *to displease.*
Screscere, *to diminish.*

The irregular verb *náscere*, to be born, is thus conjugated:—

Indef. *Simple Tenses.—Pres.* Náscere, *to be born.—Pres. Gerund.* Nascéndo, *being born.—Past Part.* Náto, *been born.——Compound Tenses.—Past.* Éssere náto, *to have been born.—Past Gerund.* Esséndo náto, *having been born.*

Ind. *Pres.* Násco, násci, násce; nasciámo, nascéte, náscono.—*Imp.* Nascéva, nascévi, nascéva; nascevámo, nasceváte, nascévano.—*Ind. Pret.* Nácqui, nascésti, nácque; nascémmo, nascéste, nácquero.—*Fut.* Nascerò, nascerài, nascerà; nascerémo, nasceréte, nascerànno.—*Cond. Pres.* Nasceréi; nascerésti; nascerébbe or nasceria. Nascerémmo; nascereste; nascerébbero, nasceriano, or nascerieno.

Imp. Násci, násca; nasciámo, nascéte, náscano.

Sub. *Pres.* Che násca, che násca, che násca; che nasciámo, che nasciáte, che náscano.—*Imp.* Che nascéssi, che nascéssi, che nascésse ; che nascéssimo, che nascéste, che nascéssero.

After this example conjugate the following :—

Soprannáscere, *to spring on or after something.*	Rinascere, *to be born again.*

The irregular verb *árdere*, to burn, is thus conjugated :—

INDEF. *Simple Tenses.—Pres.* Ardere, *to burn.—Pres. Gerund.* Ardéndo, *burning.—Past Part.* Árso, *burnt.——Compound Tenses.—Past.* Avére árso, *to have burnt.—Past Gerund.* Avéndo árso, *having burnt.*

IND. *Pres.* Árdo, árdi, arde ; ardiamo, ardéte, árdono.—*Imp.* Ardéva *or* ardea, ardevi, ardéva *or* ardea ; ardevámo, ardeváte, ardevano *or* ardéano.—*Ind. Pret.* Ársi, ardésti, árse *or* ardéo ; ardémmo, ardéste, ársero.—*Fut.* Arderò, arderai, arderà ; arderémo, arderéte, arderánno.—*Cond. Pres.* Arderéi *or* arderia, arderésti, arderébbe *or* arderia ; arderemmo, arderéste, arderebbero *or* arderíano.

IMP. Árdi, arda ; ardiámo, ardéte, árdano.

SUB. *Pres.* Che árda, che árda *or* árdi, che arda ; che ardiámo, che ardiáte, che árdano.—*Imp.* Che ardéssi, che ardéssi, che ardésse ; che ardéssimo, che ardéste, che ardessero.

After this example conjugate the following :—

Indef. Pres	*Ind. Pret.*	*Past Part.*	*English.*
Acchiúdere,	acchiusi,	acchiuso,	*to enclose.*
Chiédere,	chiési,	chiesto,	*to ask.*
Decidere,	decisi,	deciso,	*to decide.*
Elidere,	elisi,	eliso,	*to retrench*
Illudere,	illusi,	illuso,	*to mock or delude.*
Mordere,	morsi,	morso,	*to bite.*
Precidere,	precisi,	preciso,	*to shorten.*
Rídere,	risi,	ríso,	*to laugh.*
Schiudere,	schiúsi,	schiuso,	*to open.*
Spérdere,	spérsi,	sperso,	*to dissipate*
Succédere,	successi,	successo,	*to succeed.*
Uccidere,	uccisi,	ucciso,	*to kill.*

The irregular verb *rispóndere*, to answer, is thus conjugated :—

INDEF. *Simple Tenses.—Pres.* Rispondere, *to answer.—Pres. Gerund.* Rispondendo, *answering.—Past Part.* Risposto, *answered.——Compound Tenses.—Past* Avere rispósto, *to have answered.—Past Gerund.* Avéndo risposto, *having answered.*

IND. *Pres.* Rispóndo, rispondi, rispónde ; rispondiamo, rispondéte, rispondono.—*Imp.* Rispondéva, rispondévi, rispondéva ; rispondevámo, rispondevate, rispondévano.—*Ind. Pret.* Risposi, rispondésti, rispose ; rispondémmo, rispondeste, rispósero.—*Fut.* Risponderò, risponderái, risponderà ; risponderémo, risponderéte, risponderánno.—*Cond. Pres.* Risponderéi, risponderésti, risponderebbe ; risponderémmo, risponderéste, risponderébbero.

IMP. Rispóndi, risponda ; rispondiámo, rispondéte, rispóndano.

SUB. *Pres.* Che rispónda, che risponda, che rispónda ; che rispondiámo, che rispondiáte, che rispóndano.—*Imp.* Che rispondéssi, che rispondéssi, che rispondesse ; che rispondéssimo, che rispondéste, che rispondéssero.

After this example conjugate the following :—

Indef. Pres.	*Ind. Pret.*	*Past Part.*	*English.*
Accéndere,	accési,	accéso,	*to light.*
Confóndere,	confúsi,	confúso,	*to confound.*
Diféndere,	difési,	diféso,	*to defend.*
Fóndere,	fusi,	fúso,	*to melt.*
Nascóndere,	nascósi,	nascóso *or* nascosto,	*to conceal.*
Offéndere,	offési,	offéso,	*to offend.*
Préndere,	prési,	préso,	*to take.*
Réndere,	resi,	réso *or* rendúto,	*to render.*
Scéndere,	scési,	sceso,	*to come down.*
Tóndere,	tósi,	tondúto *or* tosato,	*to shear.*

The irregular verb *addúrre*, to bring, is thus conjugated :—

INDEF. *Simple Tenses.—Pres.* Addúrre, *to bring.—Pres. Gerund.* Adducéndo, *bringing.—Past Part.*—Addótto, *brought.——Compound Tenses.—Past.* Avére addótto, *to have brought.—Past Gerund.* Avendo addótto, *having brought.*

IND. *Pres.* Adduco, adduci, addúce ; adduciámo, adducéte, addúcono.—*Imp.*—Adducéva *or* adducéa, adducévi, adducéva *or* adducea ; adducevámo, adducevate, adducévano *or* adducéano.—*Ind. Pret.* Addússi, adducésti, addússe ; adducémmo, adducéste, addussero.—*Fut.* Addurrò, addurrái, addurrà ; addurremmo, addurréte, addurránno.—*Cond. Pres.* Addurréi *or* addurría, addurresti, addurrebbe *or* addurria ; addurrémmo, addurreste, addurrebbero *or* addurríano.

IMP. Adduci, addúca ; adduciamo, adducete, adducano.

SUB. *Pres* Che addúca, che adduca *or* addúchi, che addúca ; che adduciámo, che adduciáte, che addúcano.—*Imp.* Che adducessi, che adducéssi, che adducésse ; che adducéssimo, che adduceste, che adducéssero.

After this example conjugate the following :

Indef. Pres.	*Ind. Pres.*	*Ind. Pret.*	*Past Part.*	*English.*
Condurre,	condússi,	condurro,	condótto,	*to conduct.*
Dedurre,	dedussi,	dedurro,	dedotto,	*to infer*
Indurre,	indussi,	indurro,	indotto,	*to induce.*
Produrre,	produssi,	produrro,	prodotto,	*to produce.*
Ridurre,	ridussi,	ridurro	ridotto,	*to reduce*
Sedurre,	sedussi,	sedurro,	sedotto,	*to seduce.*
Tradurre,	tradussi,	tradurro,	tradotto,	*to translate.*

The irregular verb *vólgere*, to turn, is thus conjugated :—

INDEF. *Simple Tenses.—Pres* Volgere, *to turn.—Pres. Gerund.* Volgendo, *turning.—Past Part.* Volto, *turned.——Compound Tenses.—Past.* Avére volto, *to have turned.—Past Gerund.* Avendo volto, *having turned.*

IND. *Pres.* Volgo, vólgi, volge ; volgiamo, volgete, volgono.—*Imp.* Volgeva *or* volgea, volgevi *or* volgei, volgeva *or* volgéa ; volgevamo, volgevate, volgévano.—*Ind. Pret.* Volsi, volgesti, volse ; volgemmo, volgéste, volsero.—*Fut.* Volgerò, volgerái, volgerà ; volgeremo, volgerete, volgeranno.—*Cond. Pres.* Volgeréi *or* volgeria, volgerésti, volgerébbe ; volgeremmo, volgeréste, volgerébbero.

IMP. Volgi, volga ; volgiámo, volgéte, volgano.

SUB. *Pres.* Che volga, che volga, che volga ; che volgiámo, che volgiate, che volgano.—*Imp.* Che volgéssi, che volgéssi, che volgesse ; che volgessimo, che volgeste, che volgessero.

After this example conjugate the following :—

Indef. Pres.	*Ind. Pres.*	*Ind. Pret.*	*Past Part.*	*English.*
Aggiúngere,	aggiungo,	aggiunsi,	aggiunto,	*to add.*
Aspergere,	aspergo,	aspersi,	asperso,	*to sprinkle.*
Cingere,	cingo,	cinsi,	cinto,	*to gird.*
Dipíngere,	dipingo,	dipinsi,	dipinto,	*to describe.*
Emergere,	emérgo,	emersi,	emerso,	*to emerge.*
Fíngere,	fingo,	finsi,	finto,	*to feign.*
Giungere,	giungo,	giunsi,	giunto,	*to come to.*
Indulgere,	indulgo,	indulsi,	indulto,	*to grant.*
Mergere.	mergo,	mersi,	merso,	*to plunge.*
Piangere,	piango,	piansi,	piánto,	*to weep.*
Pungere,	pungo,	punsi,	punto,	*to sting*
Ravvolgere,	ravvólgo,	ravvólsi,	ravvólto,	*to wrap.*
Scingere,	scingo,	scinsi,	scinto,	*to gird.*
Úngere,	ungo,	unsi,	unto,	*to anoint.*

The irregular verb *léggere*, to read, is thus conjugated :—

INDEF. *Simple Tenses.—Pres.* Leggere, *to read.—Pres. Gerund.* Leggéndo, *reading.—Past Part.* Létto, *read.——Compound Tenses.—Past.* Avére létto, *to have read.—Past Gerund.* Avéndo letto, *having read.*

IND. *Pres.* Léggo, léggi, légge ; leggiámo, leggéte, léggono.—*Imp.* Leggéva *or* leggéa, leggévi, leggéva *or* leggéa ; leggevámo, leggeváte, leggévano.—*Ind. Pret.* Léssi, leggésti, lésse ; leggémmo, leggéste, léssero.—*Fut.* Leggerò, leggerái, leggerà ; leggerémmo, leggeréte, leggeránno.—*Cond. Pres.* Leggeréi, leggeresti, leggerébbe *or* leggería ; leggerémmo, leggeréste, leggerébbero.

IMP. Léggi, légga ; leggiámo, leggéte, léggano.

SUB. *Pres.* Che légga, che légga, che légga ; che leggiamo, che leggiáte, che léggano.—*Imp.* Che leggéssi, che leggéssi, che legésse ; che leggéssimo, che leggéste, che leggéssero.

After this example conjugate the following :—

Indef. Pres.	*Ind. Pres.*	*Ind. Pret.*	*Past Part.*	*English.*
Affiggere,	affiggo,	affissi,	affisso,	*to affix.*
Affliggere,	affliggo,	afflissi,	afflitto,	*to pain.*
Configgere,	configgo,	confissi,	confitto,	*to nail.*
Distrúggere,	distrúggo,	distrussi,	distrútto,	*to destroy.*
Eléggere,	eléggo,	eléssi,	elétto,	*to elect.*
Figgere,	figgo,	fissi,	fitto *or* -sso,	*to fix.*
Infiggere,	infiggo,	infissi,	infitto *or* -sso.	*to nail.*
Preeléggere,	preeléggo,	preeléssi,	preelétto,	*to prefer*
Protéggere,	protéggo,	protéssi,	protétto,	*to protect.*
Riléggere,	riléggo,	riléssi,	rilétto,	*to read again.*
Struggere,	strúggo,	strússi,	strútto,	*to wear out.*
Trafiggere,	trafiggo,	trafissi,	trafisso *or* -tto,	*to pierce.*

The irregular verb *cógliere* or *córre*, to gather, is thus conjugated :—

INDEF. *Simple Tenses.*—*Pres.* Cógliere *or* córre, *to gather.*—*Pres. Gerund.* Cogliéndo, *gathering.*—*Past Part.* Cólto, *gathered.* ——*Compound Tenses.*—*Past.* Avére cólto, *to have gathered.*—*Past Gerund.* Avéndo colto, *having gathered.*

IND. *Pres.* Cóglio *or* cólgo, cógli, cóglie ; cogliamo, cogliéte, cólgono.—*Imp.* Coglieva *or* cogliéa, cogliévi, cogliéva *or* cogliéa ; coglievámo, coglieváte, cogliévano.—*Ind. Pret.* Cólsi, cogliésti, cólse ; cogliémmo, coglieste, cólsero.—*Fut.* Cogliero *or* corro, coglierái or corrái, coglierà or corrà ; coglierémo or corremo, coglieréte *or* corréte, coglieránno *or* corránno.—*Cond. Pres.* Coglieréi, *or* corria ; coglierésti *or* corrésti ; coglierébbe, corrébbe, coglieria, *or* corria. Coglierémmo *or* corremmo ; coglieréste *or* corréste ; coglierébbero *or* corrébbero, coglieriano *or* corriano.

IMP. Cogli, cólga *or* coglia ; cogliámo, cogliéte, cólgano *or* cógliano.

SUB. *Pres.* Che cóglia *or* cólga ; che coglia *or* cólga, che cóglia *or* cólga ; che cogliámo, che cogliate, che cógliano *or* colgano.—*Imp.* Che cogliéssi, che cogliéssi, che cogliésse ; che cogliessimo, che cogliéste, che cogliéssero.

After this example conjugate the following :—

Indef. Pres.	*Ind. Pres.*	*Ind Pret.*	*Past Part.*	*English.*
Accógliere *or* accórre,	accólgo,	accolsi,	accólto,	*to welcome.*
Distógliere *or* distórre,	distolgo,	distólsi,	distólto,	*to remove.*
Raccógliere *or* raccorre,	raccólgo,	raccólsi,	raccolto,	*to gather.*
Scégliere *or* scérre,	scélgo,	scélsi,	scélto,	*to choose.*
Tógliere *or* torre,	tólgo,	tolsi,	tolto,	*to lay hold.*

KEY TO EXERCISES.

Ex. 34.—1. I take a walk every day at seven o'clock. 2. These gloves cost two shillings. 3. Obedient children deserve the love of their parents. 4. A young child seldom reflects. 5. Some lose ; others gain. 6. These boys repeat their lesson while these girls prattle. 7. The English scarcely open their mouth when they speak. 8. Anthony found a purse which contained several gold coins. 9. Thou art cheerful because the master praised thee. 10. I played the pianoforte yesterday and my sister sang a new song.

Ex. 35.—1. Il signor N. mi ha invitato al pranzo ; penso che vi trovero una numerosa compagnia. 2. Uscira ella oggi a cavallo? 3. Le mie sorelle arriveranno presto. 4. Pietro vi rendera tutto quello ch'egli ha preso. 5. Una volta renderemo conto delle nostre azioni. 6. Risponderò alla sua lettera ai nove di questo mese. 7. Quando finirete voi? 8. Avrei già finito, s'ella non m'avesse impedito. 9. Finite adunque. 10. Se voi amaste veramente la lingua italiana, la studiereste con piu diligenza. 11. Vorrei che voi terminaste l'opera che avete cominciata. 12. Giovanni, porta susine, pere e pomi.

Ex. 36.—1. Ritornando a casa ho trovato vostro fratello. 2. Non parlando voi italiano, dovete annoiarvi qui. 3. Non sapendo dove trovarla, sono ritornato. 4. Federico è punito. 5. Onora tuo padre e tua madre, e sarai onorato. 6. Questo libro sara legato domani. 7. Siate virtuosi e ne sarete certamente premiati. 8. Giovanni é stato punito per non aver terminato il suo tema. 9. Parlate ad alta voce, affinche vi si intenda. 10. È tristo d'essere odiato da tutti. 11. Egli sente piacere nell'esser lodato. 12. Abbiamo colto molte fragole.

Ex. 37.—1. Mio zio arriverà questa sera ; noi ci divertiremo bene. 2. Perche vi affliggete voi? 3. Mi affliggo della morte di mio cugino. 4. Rallegratevi, amici, del poco che avete! 5. Non vi fidate di lui. 6. Ricordatevi della vostra promessa. 7. Copritevi col vostro mantello. 8. Mi serviro dei vostri libri. 9. Noi ci serviamo spesso di questa carrozza. 10. Io mi vesto. 11. Noi ci vestiremo piu tardi. 12. A che ora vi levate voi ordinariamente? 13. Mi levo ogni mattina alle sei, e mi corico alle nove. 14. Ci leviamo piu tardi di lei. 15. Riposatevi un poco. 16. Mi riposero un momento; sono stanchissimo. 17. Come si chiama questo giovane? 18. Credo ch'egli si chiami Guglielmo. 19. Questi signori si sono molto divertiti al ballo. 20. Essi si sono proposti d'andarvi anche la settimana che viene.

Ex. 38. — 1. Si dice che la signora Johnson si maritera. 2. Si conoscono gli amici nelle disgrazie. 3. Si cerca quasi sempre la fortuna, dove non è. 4. In Europa si parlano cinquanta tre lingue. 5. Non se ne parla piu. 6. Che cosa bisogna fare per impedire una tal disgrazia? 7 Bisogna sempre lavorare ; non bisogna esser pigro. 8. Bisognera aver pazienza. 9. Bisognava ch'io scrivessi una lettera. 10. Me ne vo. 11. Se ne va ella gia? 12. Bisogna ch'io me ne vada. 13. La di lei madre non se ne va ancora. 14. Mi scusi, mia madre se n'e gia andata, ed i miei fratelli se ne andranno subito. 15. Aspetti ancora un momento ; ce ne andremo insieme.

MINERALOGY.—IV.

[*Continued from p. 308.*]

DESCRIPTIVE MINERALOGY: THE NATIVE ELEMENTS, SULPHIDES AND ARSENIDES.

1. NATIVE ELEMENTS.

OF about seventy chemical *elements*, or substances which have as yet defied all endeavours to split them up into simpler substances, comparatively few are known in a *native* or uncombined condition. Copper, for example, is an element. Hitherto it has defied all endeavours to split it up into constituent substances. Occasionally this metal appears as copper—that is, in its native state ; but most usually it is found compounded with other elements—oxygen, sulphur, carbon. In copper pyrites, the copper is in chemical combination with sulphur, and a new body, having a totally different appearance from either sulphur or copper, is found.

In malachite, again, the metal is joined with oxygen and carbon, making a carbonate of copper. The copper, sulphur, oxygen, and carbon are elements, and the pyrites and malachite are compounds. Some, indeed most, bodies are never found in their native or elementary state. The reason of this is that the affinity they exhibit for oxygen, or some other element, is so great, and the opportunities they have of obeying the impulse so numerous, that it becomes a certainty that the union of the two elements will be made. An example of this is seen in the case of iron. If a piece of that metal be at all exposed to the air, it soon rusts, or, in other words, the oxygen of the air, having a great affinity for iron, enters into combination with it and forms the oxide of iron, or rust. But a piece of gold will not lose its brightness, though it be exposed to the air for years, since oxygen has scarcely any affinity for gold.

The native elements fall naturally into two subdivisions, the metals and the non-metals.

In the former subdivision the chief minerals are gold, silver, platinum, palladium, mercury, and copper. With them are placed the native alloys or mixtures of two metals.

GOLD (Au) is fusible and soluble in aqua regia (a mixture of nitric and hydrochloric acids). It crystallises in the Cubic system, in octahedra, sometimes with winged edges, and other forms; but is more often found in a granular condition, or in waterworn rounded nodular masses known as "nuggets." It is metallic in lustre, gold-yellow to brass-yellow in colour, and extremely ductile and malleable. $H = 2{\cdot}5 - 3$. $G = 15 - 19$. Native gold always contains more or less silver and sometimes copper. This accounts for the wide variation in its specific gravity. When the silver amounts to 20 per cent., the alloy is known as *electrum*. Native gold occurs either in quartz veins traversing metamorphic rocks of the older Palæozoic systems (*see* lessons on Geology), or as grains and nuggets ("stream gold") in alluvial deposits, such as river-gravels, derived from their disintegration, which may be of any geological age. Gold is not known in any compound ore. It occurs in small quantities in Cornwall, at several places in Wales and Scotland, and in county Wicklow; more abundantly in Transylvania, the Ural Mountains, Southern India, China, Japan, Brazil, and other parts of South America; but in far greater quantities in California, South-Eastern Australia, and South Africa.

SILVER (Ag) is fusible and soluble in nitric acid (HNO_3), giving, on the addition of hydrochloric acid (HCl) to the solution, a white precipitate, which is silver chloride ($AgCl$). It crystallises in the Cubic system, but appears generally in filiform and arborescent shapes, often alloyed with gold or copper. The silver rootlets penetrate rocks usually in the neighbourhood of dykes. The mines of Kongsberg, in Norway, yield fine specimens. The largest mass ever found was obtained in the Huantajaya mines in Peru; it weighed 8 cwt. Beautiful specimens are found with native copper near Lake Superior. The filaments of the silver interlace the copper rootlets. This fact seems to point to electricity as the depositing agent, for if the metals had been in a fused state they must have become alloyed with each other. Silver is metallic and silver-white in colour, but tarnishes readily. It is ductile and malleable. $H = 2{\cdot}5 - 3$. $G = 10 - 11$. Silver occurs in strings or veins in slate or other sedimentary rocks and in eruptive rocks. In addition to the localities just mentioned, Freiberg (in Saxony), Chili, and Mexico are important; but greater yields are derived from Bolivia, and especially from Nevada. More silver is, however, obtained from ores, sulphides, arsenides, antimonides, and chlorides than from the native metal.

PLATINUM (Pt) is infusible, but is soluble in aqua regia. It crystallises in the Cubic system, occurring rarely in cubes; but is more often found in grains in alluvial gravel, being usually alloyed with some of the rarer metals—iridium, rhodium, osmium, palladium. It was first discovered in the deposits of Choco, in South America, where it received its name platina, "little silver." Since then it has been supplied from the gravel at the foot of the Ural Mountains, and so plentiful was the yield that platinum was once used for coins in Russia. It is metallic, steel-grey in colour, and very ductile. $H = 4 - 4{\cdot}5$. $G = 17 - 21{\cdot}5$, the latter when the metal is purified, it being one of the heaviest known substances. The great infusibility of platinum, and its power of withstanding the action of acids, render it most valuable for chemical and physical apparatus, and the recent demand for it in connection with electric lighting has much enhanced its money value.

PALLADIUM (Pa) a related, lighter and more soluble metal, is far more rare. It occurs in grains or small regular octahedra with alluvial gold and platinum. The Wollaston medal, annually awarded by the Geological Society in honour of the mineralogist who, in 1803, discovered this metal, used to be made of palladium, but the supply proved insufficient.

IRIDOSMINE, an alloy of the metals osmium (Os) and iridium (Ir), occurs in granules in the Urals with platinum. $H = 7$. $G = 20$. On account of its hardness and resistance to acid, it is used for the tips of gold pens, the pivot of mariners' compasses, etc.

MERCURY, or Quicksilver (Hg), the only well-known metal which is liquid at ordinary temperatures, is sometimes found in small globules in a pure state in the mines of cinnabar, its sulphide and chief ore, as at Idria, in Carniola, and at Almaden, in Spain. It is the densest known liquid, $G = 13·5$.

Alloys containing mercury are known as *amalgams*. **NATIVE AMALGAM**, which is about 65 per cent. mercury and 35 per cent. silver, occurs in rhombic dodecahedra of the Cubic system at Landsberg, in Bavaria, and at Almaden. $H = 3 - 3·5$. $G = 10·5 - 14$.

COPPER (Cu), to which some allusion has already been made, is fusible, giving a green colour to the flame, and dissolves in ammonia, forming a blue solution. It crystallises in the Cubic system, occurring in octahedra and cubes, but also commonly dendritic. It is copper-red in colour and ductile. $H = 2·5 - 3$. $G = 8·5 - 8·9$ It occurs in veins, in serpentine, and near dykes in igneous rocks, and is one of the chief commercial sources of the metal. Cornwall, Tavistock, Siberia, Lake Superior, and Burra-Burra, in Australia, are among the chief localities for it.

IRON (Fe) is chiefly known in a native state in meteorites, in which it is usually alloyed with nickel and sometimes with other metals, besides containing "occluded" hydrogen. Iron of terrestrial origin, however, has been found by Professor Nordenskiöld, in small grains disseminated in basalt, at Ovifak, in Greenland. The iron of commerce is all obtained from ores, mainly oxides and carbonates. It is fusible with difficulty, giving a bottle-green borax-bead in R.F.; is Cubic, steel-grey, highly magnetic and ductile; and has a hackly fracture. $H = 4·5$. $G = 7·5$.

BISMUTH (Bi) is chiefly found in a native state. It is fusible, leaving a yellow-brown areola on the charcoal, and is soluble in nitric acid. It crystallises in rhombohedra, resembling cubes, but is often dendritic. It is metallic, silver-white, diamagnetic, and sectile. $H = 2 - 2·5$. $G = 9·7$. Botallack, in Cornwall; Schneeberg and elsewhere in Saxony; Joachimsthal in Bohemia; and Bolivia, are sources of supply, the metal being in demand for the manufacture of solder and of fusible metal for stereotyping.

LEAD, TIN, ARSENIC, and **ANTIMONY** have been found native in very small quantities.

Among the non-metallic elements occurring native, the chief are sulphur and carbon, the latter under the two specific forms of diamond and graphite.

SULPHUR (S) burns with a blue flame and a sulphurous odour. It occurs in perfect octahedra of the Prismatic system, associated with gypsum ($CaSO_4 + 2H_2O$) or with celestine ($SrSO_4$), in volcanic districts, or it may be granular, interlaminated with limestone. It is transparent to translucent and resinous. $\mu = 2 - 2·2$. In colour it is yellow to red, brown, or grey, orange when containing selenium, brown with bitumen. The streak is yellow to white. It is sectile. $H = 1·5 - 2·5$. $G = 2$. Most of the sulphur of commerce is obtained native from the valley of Noto and Mazzaro in Sicily; but large quantities are also distilled from iron and copper pyrites.

DIAMOND (C) is unaffected by acids, but burns in O.F. It is almost pure carbon. When heated to redness in a cage of platinum wire, and plunged into a jar of oxygen, the gem burns into carbonic acid gas, leaving sometimes a little silica ash in the cage. It crystallises in the Cubic system in octahedra, triakisoctahedra, and hexakisoctahedra, which often have curved edges, and it exhibits perfect octahedral cleavage. It is transparent or translucent and adamantine. $\mu = 2·44$. It is colourless, straw-coloured, especially in the South African stones, or very rarely blue. It exhibits a play of colours, and is sometimes heliophosphorescent. It becomes positively electric on friction; but is a very bad conductor. $H = 10$. $G = 3·5 - 3·6$. Flawed specimens, which are powdered for polishing and cutting purposes, are known as *boart*, and a black non-crystalline variety, known as *carbonado*, found in Brazil, is set in steel crowns and used for

Fig. 26.—A DIAMOND IN ITS MATRIX.

rock-boring. For glass-cutting purposes, the curved edges are preferred. The chief localities for this gem are India, Brazil, and South Africa, which last has during recent years far surpassed all other sources of supply. Diamonds are found chiefly as alluvial pebbles, but also in various rocks. The "blue stuff" of the Kimberley mines, however—a remarkable talcose serpentinous breccia, apparently formed in the neck of a volcano at no very high temperature, possibly a mud-volcano—seems more likely to be the original matrix of the diamond than any other. In spite of many statements to the contrary, the diamond seems not to have been as yet made artificially.

To cut it, in order that its great refractive and dispersive power may be exhibited to advantage, it is fitted with a metallic cement into a handle, and then pressed down upon a disc of steel about six or eight inches in diameter, which rapidly revolves horizontally. The steel is impregnated with diamond dust, and this wears a facet. Great art is required, for there is a grain in the diamond, and if the stone be set so that the plate attempts to cut it against the grain, the steel is cut and not the diamond. Diamond-cutting was first attempted in Europe by Louis Berquen, a citizen of Bruges, in 1456, and the Dutch monopolised the trade until very recently. Before the introduction of machinery the process was most tedious. Two diamonds, set in metallic cement, were rubbed by hand one against the other until a facet was worn in each.

Diamonds are sold by weight. A *carat* is the unit employed, and is about 3⅛ grains troy. The term is derived from the name of a bean used in Africa to weigh gold. These beans were carried to India, and there were employed to weigh diamonds. To determine the value of a diamond of moderate size, double the weight in carats, and multiply the square of the product by £2. Thus, a cut diamond weighing one carat would be worth £8; one weighing ten carats, £800. The largest diamond on record belonged to the Great Mogul. It was found in 1550, in the mine of Colone. It weighed in its rough state 900 carats, but in cutting was reduced to 272½ carats.

GRAPHITE, also known as *plumbago* or *blacklead*, though it has nothing to do with the metal lead, is pure carbon (C) or nearly so, sometimes containing a little iron-oxide, silica, or alumina, less than 5 per cent. in all. It is infusible alone, and is unaffected by acids; but deflagrates with nitre (KNO_3) on platinum foil, forming potassium carbonate (K_2CO_3). It crystallises in the Hexagonal system, occurring in thin six-sided plates, though far more often granular or massive. It is occasionally fibrous. Graphite is opaque, metallic, iron-black to steel-grey, and sectile. Its streak is black and shining, and it marks paper, as is familiar to us in writing or drawing in pencil. $H = 1 - 2$. $G = 1{\cdot}8 - 2$. In thin laminæ it is flexible, and, owing to its high conductivity, it is cold, like a metal, to touch. It occurs in beds in altered limestones, schists, gneiss, or other metamorphic rocks—as at Borrowdale, in Cumberland, where the mines long worked for the manufacture of pencils are now exhausted; at Sturbridge, Massachusetts; in the Laurentian rocks of Canada; in Siberia; and in Ceylon. Besides its use for pencils, graphite is used in making crucibles, glazing gunpowder, polishing stoves and other iron work, diminishing friction, and electrotyping. It is produced in crystalline plates from coal, on the surface of pigs of inferior or mottled cast-iron.

2. SULPHIDES, ARSENIDES, ETC.

This is a class containing many of the chief ores of the metals and of the semi-metals arsenic and antimony.

DYSCRASITE, or antimonial silver (Ag_4Sb), is an antimonide of silver, containing from 77 to 85 per cent. of silver. It is fusible with fumes and a sublimate of antimony, and a bead of silver, crystallises in the Prismatic system, and is metallic, silver-white, and sectile. $H = 3{\cdot}5$. $G = 9{\cdot}6$. It is found at Andreasberg in the Harz Mountains.

NICKELINE, nickelite, Kupfernickel, or copper-nickel (Ni_2As)—the two latter names being misleading—is an arsenide of nickel, and one of the chief sources of that metal. Before the blowpipe it gives off arsenical fumes and yields a white, magnetic, metallic globule of nickel; and it gives a green solution in aqua regia. It crystallises in the Hexagonal system, but is usually amorphous. It is metallic and of a copper-red colour, whence its German name *Kupfernickel*. It has a grey tarnish and a brownish-black streak, and is brittle. $H = 5{\cdot}5$. $G = 7{\cdot}5$. Nickeline occurs in association with various ores of cobalt, silver, and copper in Saxony, the Harz Mountains, and Bohemia, and less abundantly in Cornwall.

SMALTINE, or grey cobalt ($CoAs_2$), is an arsenide of cobalt, and an important source of both arsenic and cobalt. It gives off arsenical fumes, and yields the characteristic blue borax-bead of cobalt-compounds. In nitric acid it gives a pink solution. It crystallises in the Cubic system, often in combinations of the cube, octahedron, and rhombic dodecahedron, and also occurs amorphous. It is metallic, tin-white, and brittle, and has a greyish-black streak. $H = 5{\cdot}5$. $G = 6{\cdot}5 - 7$. It is found in Cornwall, Saxony, Bohemia, and in the silver mines of Chili.

GALENA (PbS), the monosulphide and chief ore of lead, decrepitates before the blowpipe, giving off a sulphurous odour and yielding a lead bead and a yellow incrustation. It is soluble in nitric acid. It crystallises in the Cubic system, cleaving parallel to the faces of the cube; is metallic, lead-grey, and sectile. H = 2·5. G = 7·5. Some silver sulphide is almost always present in galena. It occurs in veins, associated with baryte and fluor, in Cornwall, Derbyshire, Leadhills in Lanarkshire, and at many foreign localities.

ARGENTITE, or silver-glance (Ag_2S), so called from a German mining-term *glanz* for a grey metallic mineral, is one of the chief ores of silver, of which it is the monosulphide. Before the blowpipe it swells up, gives off sulphur fumes, and yields a silver bead. In nitric acid the silver dissolves, leaving the sulphur. It crystallises in the Cubic system in dodecahedra or cubes, and is often dendritic. It is metallic, and before exposure to light has a bright lustre, but soon tarnishes to a dull blackish-grey. It is very sectile. H = 2 – 2·5. G = 7·2. Argentite occurs in Cornwall, Saxony, Bohemia, Hungary, at Kongsberg in Norway, Chili, Peru, Mexico, and Nevada.

BLENDE (ZnS), the monosulphide of zinc and a chief ore of that metal, is almost infusible alone, but with sodium-carbonate gives a green flame and a white areola which becomes green with cobalt nitrate. It crystallises in the Cubic system, often in tetrahedral and twinned forms, has an adamantine lustre, and is black or brown in colour. H = 3·5 – 4. G = 4. Blende contains 66 or 67 per cent. of metallic zinc, and occurs commonly in Cornwall and elsewhere. Its name means "blind" or "delusive," since it was thought worthless, as containing no lead, though sometimes resembling galena. It is distinguished from cassiterite, or tinstone, which it more frequently resembles, by being softer and more readily cleavable, and by dissolving in hydrochloric acid (HCl) with an evolution of sulphuretted hydrogen (H_2S), a gas at once recognised by its smell of rotten eggs. Blende occurs in lodes, frequently with galena, and is known to miners as "Black Jack."

REDRUTHITE, or copper-glance (Cu_2S), a scarce but valuable ore of copper, gives a blue flame, effervesces and gives off fumes of sulphur, and yields a red bead of copper. In nitric acid its copper dissolves, forming a blue solution. It is generally amorphous, but does crystallise in the Prismatic system. It is metallic, blackish-grey, and sectile. H = 2·5 – 3. G = 5·6. Redruthite occurs at Redruth, in Cornwall, whence it derives its name, and elsewhere, and contains 80 per cent. of copper.

CINNABAR (HgS), mercury-monosulphide, is practically the sole source of mercury. It volatilises on charcoal; in an open tube gives sulphur fumes and a sublimate of mercury; and is insoluble in hydrochloric or nitric acids, but soluble in aqua regia. It crystallises in the Hexagonal system, but is generally granular. It is a cochineal red, with a scarlet streak and an adamantine lustre. H = 2·5, G = 8. Its general situation is in slate rocks, but at Idria, in Carniola, it is found in limestone. Almaden, in Spain, is the only other European locality which yields it, but it occurs in China, Japan, Chili, Peru, Mexico, and California. When purified it is known as *vermilion*.

GREENOCKITE (CdS), a rare mineral, originally found at Bishopton, near Greenock, is a chief source of cadmium. In a closed tube it decrepitates and turns red, and it dissolves in hydrochloric acid, giving off sulphuretted hydrogen. It crystallises in the Hexagonal system, is orange and adamantine. $\mu = 2·68$. The pigment known as cadmium-yellow is an artificial sulphide.

PYRITE (FeS_2), or iron-pyrites, iron-disulphide, known to miners as "mundic," is one of the commonest of minerals. It gives a blue flame, a sulphur odour, a black magnetic bead in R.F., and a green glass with borax. It crystallises in the Cubic system, especially in cubes, pentagonal dodecahedra, and combinations of the two forms. The faces of the cubes are often striated parallel to the edges of the pentagonal dodecahedron. The lustre of the mineral is often splendently metallic, and its colour so like brass as to be often mistaken by beginners for that artificial alloy. The streak is greenish, and the fracture sub-conchoidal. Pyrite, unlike gold, with which also it is often confused, is brittle, and so hard as formerly to have been used (as in wheel-lock guns, for instance) for striking a light with steel, whence its name, which is derived from the Greek *πῡρίτης, pūritēs*. H = 6 – 6·5. G = 5. Some pyrite contains gold in sufficient quantity to be worth extracting; but the sulphur renders it worthless as an ore of iron. It is, however, largely used in the manufacture of sulphuric acid, copperas (iron-sulphate), and alum.

MARCASITE, or white iron-pyrites (FeS_2), has the same composition as pyrite, but is of a lighter brass-yellow, often greenish; crystallises in the Prismatic system; occurs often in radiating nodular masses in the Chalk and other formations; is more commonly associated with organic forms as a fossilising agent, and is far more readily decomposed by weather-action. H = 6 – 6·5. G = 4·65 – 4·9. Cubes of pyrite will retain their sharp angles for years on the face of a slate-quarry; whilst the cones, fruits, ammonites, etc., fossilised in marcasite, soon lose their bright brassy lustre and crumble into hydrous iron-oxide, and the nodules in the Chalk are similarly coated with brown rust.

REALGAR (AsS), arsenic disulphide, the name of which comes to us from the Arab alchemists, crystallises in the Oblique system, has a resinous lustre, and is of a beautiful aurora-red colour. On exposure it speedily turns to orpiment, with which it commonly occurs.

ORPIMENT (As_2S_3), named from the Latin *auri pigmentum*, gold paint, with reference to its former use, is arsenic sesqui-sulphide. Though differing quantitatively from realgar, it gives the same blowpipe reactions—a blue flame, sulphur odour, and arsenic sublimate. It crystallises in the Prismatic system, but is mostly amorphous. It is resinous, and of a lemon-yellow colour. $H = 1·5$. $G = 3·5$. The sesqui-sulphide of arsenic, when prepared artificially as a pigment, was called "king's yellow."

STIBNITE, antimonite, antimony-glance, or grey antimony (Sb_2S_3), antimony sesqui-sulphide, the chief source of the metal, melts in a candle flame, colouring it green, and giving off sulphur fumes and a sublimate of antimony. In caustic potash (KHO) it gives a yellow solution. It crystallises in the Prismatic system, often in slender radiating needle-like prisms; but in Japan in large columnar crystals with splendent metallic lustre. It is a lead-grey with a blue or iridescent tarnish, and is sectile. $H = 2$. $G = 4·6$. It occurs in Cornwall, Scotland, Hungary, and elsewhere. The powdered mineral has been used from early times for darkening the eyelids, as told in the story of Jezebel.

COBALTINE, or cobalt-glance ($CoS_2 + CoAs$), the arseno-sulphide of cobalt, resembles pyrite in form and smaltine in its other characters. It is silver-white, with a pink tarnish. It is highly valued as a cobalt ore.

NICKEL-GLANCE ($NiS_2 + NiAs$), or white nickel, the corresponding salt of nickel, is very similar in form and colour, occurs with ores of cobalt, and is a valuable ore of nickel.

MISPICKEL, arsenopyrite, or arsenical iron pyrites ($FeS_2 + FeAs_2$), the chief commercial source of arsenic, gives arsenical fumes and a black magnetic bead in R.F. and a green B.B. It crystallises in the Prismatic system, and is silver-white with a pale copper-red tarnish. $H = 5·5$. $G = 6$. Mispickel is frequently found in veins and in many crystalline schists and serpentines.

PYRRHOTINE, or magnetic pyrites (Fe_6S_7), gives a black magnetic bead in R.F., is Hexagonal, but more generally massive, reddish or brownish bronze-coloured and magnetic. It is further distinguished by being softer than pyrite. $H = 3·5 - 4·5$. $G = 4·6$. It is used for the same manufactures as pyrite, and sometimes yields a little nickel.

ERUBESCITE, or horse-flesh copper-ore ($3Cu_2S + Fe_2S_3$), a valuable copper ore, gives off sulphur fumes, yields the characteristic beads of copper with borax or carbonate of soda, and is partly soluble in strong hydrochloric acid. It crystallises in the Cubic system, but is usually amorphous, and is metallic and copper-red with an iridescent tarnish, whence its popular name. $H = 3$. $G = 5$. It occurs in Cornwall, plentifully in parts of Chili, Peru, and Mexico, and elsewhere.

CHALCOPYRITE, or copper-pyrites ($Cu_2S + Fe_2S_3$) gives the green borax bead and is soluble in aqua regia. It crystallises in the Pyramidal system, but is generally massive. It is metallic, brass-yellow, often with an iridescent tarnish, when it is known as "peacock copper," and with a greenish-black streak. Its brittleness and non-malleability distinguish chalcopyrite from gold; its softness, from pyrite. $H = 3·5 - 4$. $G = 4·2$. Though not containing more than 35 per cent. of copper, chalcopyrite is so abundant as to be the chief ore of that metal. Cornwall is its greatest repository. By its decomposition many minerals are produced—*blue vitriol*, *malachite*, *chrysocolla* (hydrated silicate of copper), *black copper ore*, and *limonite* (hydrated oxide of iron).

GREY COPPER ORE ($4Cu_2S + Sb_2S_3$), whenever crystallised, so invariably appears in tetrahedra that it has been called *tetrahedrite*. No ore has such a variable composition as grey copper ore. When it contains 30 per cent. of silver in place of part of the copper, it is called *argentiferous grey copper ore* or *silver fahlerz*. It is known in Germany to contain mercury, and when from 7 to 16 per cent. of this metal is present it is called *spaniolite*. The grey copper ore of the Cornish mines is seldom argentiferous. It may be described as a complex sulph-antimonite of copper, sometimes containing iron, zinc, silver, mercury, gold, platinum, and arsenic. It gives a sublimate of antimony, sulphur fumes, and with soda a bead of copper. Its tetrahedra and tritetrahedra belong to the Cubic system. It is metallic and grey to black. $H = 3 - 4$. $G = 4·5 - 5$. It occurs in Cornwall, is rich in silver at Freiberg, in Saxony, and is worked for both silver and copper in Nevada and California.

STEPHANITE, or brittle silver ore ($5Ag_2S + Sb_2S_3$), the sulph-antimonite of silver, is an important ore of the metal. It crystallises in the Prismatic system, is metallic and iron-black. $H = 2 - 2·5$. $G = 6·26$. It gives a silver bead with soda and dissolves in nitric acid, leaving a residue of sulphur and oxide of antimony. A strip of copper in this solution becomes plated with silver. Stephanite is commonly associated with argentite.

PYRARGYRITE, or dark ruby silver ($3Ag_2S + Sb_2S_3$), the sulph-antimonite, and **PROUSTITE**, or light ruby silver ($3Ag_2S + As_2S_3$), the sulph-arsenite of silver, graduate into one another and differ but little. They decrepitate, giving off fumes of sulphur and yielding a sublimate, and in R.F. a silver bead. They crystallise in the Hexagonal system, in prisms terminated by rhombohedral faces, are adamantine, and range in colour from black to cochineal-red, and from that tint to carmine respectively. They blacken on exposure to light, and are deeper in tint as the antimony preponderates over the arsenic. The Harz, Chili, Peru, Mexico, and California are the chief localities for ruby silvers.

BRITISH COMMERCE.—I.

OUR IMPORTS.

In no respect is the greatness of the United Kingdom so strikingly exemplified as in a comparison of its commerce with the commerce of other nations. Though its superficial area is little more than a fourth of the combined areas of France, Holland, Spain, Denmark, and Portugal, yet its annual imports and exports exceed by at least £20,000,000 the united imports and exports of these countries. A still more striking illustration of the supremacy of Britain in the trading world is furnished from the returns of the tonnage passing through the Suez Canal, the tonnage of British vessels being to the tonnage of the vessels of all other nations in the proportion of nearly five to one.

The position of British trade being as stated, no subject should possess greater interest to English students than the subject proposed to be treated in these lessons. It is not intended to deal with all the products that are brought to our ports by every wind that blows, but only with a select and illustrative few, the primary aim being to stimulate the student to more extended investigation in the same field. With these preliminary observations, and before dealing with particular products, we shall proceed to indicate briefly, first (in the order of the value of the produce they send us), the leading countries that supply us with produce; and, second, the general routes taken by the vessels that bring us this produce, with such details regarding shipping as may be interesting and useful.

To our total annual imports of £420,000,000 the greatest tributary amongst foreign nations is the United States, the chief articles that that country pours upon our shores being cotton, wheat and flour, cattle, bacon, beef, hams, cheese, and lard. After the United States comes France, her annual imports to this country being £45,000,000, less than half the value of the imports from the former country. This £45,000,000 is made up mainly by wine, woollen stuffs, silks, butter, sugar (refined and unrefined), eggs, and potatoes. Germany's £26,000,000 come over in the shape of sugar (refined and unrefined), eggs, hemp, timber, and paper. Holland is our chief supplier of margarine and fresh pork, and Belgium of rabbits, of silk ribbons, and, after Russia, of flax. From Russia comes a third of the wheat we import, half the flax, and the best quality of bristles. To Spain we are indebted for copper, iron ore, vegetable fibres for paper-making, fruit, and wine; to Denmark for our best butter; to Sweden and Norway for timber; to Egypt for cotton seeds, as well as raw cotton; and to China for tea and raw silk. Of other foreign countries that supply us with produce may be enumerated, in the order of their annual imports, Brazil, Roumania, Argentine Republic, Asiatic Turkey, and Chili.

Out of the 96 millions sterling received from our dependencies, India sends 32½ millions, the bulk of this being made up of tea, cotton, wheat, flax, linseed, and rape-seed. The Australasian Colonies make a good second with 29½ millions sterling, in the form mostly of wool, which accounts for 19 millions, other leading elements being fresh mutton and wheat. Following Australasia, but at a considerable distance, is British North America, with only 12½ millions sterling. From these as yet scarcely developed regions come timber, wheat, and wheatmeal. From the Straits Settlements comes quite the half of our imported tin; from South Africa, wool and copper-ore; from Ceylon, tea and coffee; from British West India Islands and Guiana, sugar; and from Canada, cattle, butter, and cheese.

Such, in their order, are the countries that send us three-fourths of our imports. The leading ports that this produce comes to, and whence it is distributed throughout this country, or else re-exported, are, in the order of the value of the goods entered at them and according to the figures of 1890, as follows:—London, £144,515,992; Liverpool, £108,476,672; Hull, £24,561,830; Harwich, £14,559,270; Glasgow, £13,127,550; Newhaven, £10,938,498; Folkestone, £10,815,957; Leith, £10,347,097; Bristol, £8,384,636; Dundee, £4,451,716; and Belfast, £2,609,329.

Out of a total importation of 629,236,209 lb. of sheep's and lambs' wool, there were entered at London 500,002,398 lb. London similarly receives the chief consignments of tea, her imports out of a total of 223,494,511 lb. being 223,039,660; and 22,343,192 lb. of coffee out of a total of 28,112,210 lb. Liverpool is the chief port for unmanufactured tobacco, of which the total is 65,729,970 lb., Liverpool contributing 33,034,634 lb. and London 24,323,818 lb. This is due to the convenience of Liverpool for the American trade, from which comes 53,428,799 lb. of tobacco out of the total. Their vicinity to Continental ports makes Harwich, Newhaven, and Southampton the landing-places for eggs; and Dundee, as being the centre of the jute manufacture, receives the most of that article. Causes like these hinted at—convenience for the shipping, and nearness to the market or place of consumption—determine the ports at which certain cargoes are discharged.

SEA-ROUTES.

An essential condition of extended industry is exchange. Without the possibility of exchanging commodities man would confine his efforts simply to the satisfying of his own individual wants. To exchange commodities, again, on a large scale, it is very evident that adequate means of conveying them from place to place must be forthcoming Without these means commerce, which is none other than the exchanging of commodities, must have been ever restrained within very narrow limits; and, as a consequence, industry itself must have been correspondingly confined

In those early days when the camel represented the most advanced method of conveying merchandise, the powers of production known to and exercised in the present day would have been of little avail. The surplus produce of one district could never have been exchanged for the surplus produce of another to the extent now carried on, and industry would have led a languishing life, oppressed by its own offspring. Thus it is that the merchant plays as important a part in the maintenance and forward movement of a community as the manufacturer. It appears, then, that a knowledge of the routes whereby merchants send their produce is just as important as a knowledge of the processes of manufacture.

Taking England as the centre whither the merchandise is brought, we find it convenient to divide the routes we are to consider into six groups:—

I. From North Europe, embracing the Baltic Sea.

II. South Europe, embracing the Black Sea and Mediterranean.

III. Africa.

IV. America, by the Atlantic.

V. America, by the Pacific.

VI. Australasia, India, and China.

I. The principal ports whence ships issue into the Baltic are Cronstadt, St. Petersburg, Riga, Memel, Danzig, Helsingfors, Abo, Gefle, and Stockholm. These are frozen up for at least five months in the year, so that the commerce of Russia, Prussia, and Sweden, so far as it is dependent upon these ports, is during that period practically at a standstill. From Cronstadt (which since the dredging of the Neva has been largely superseded as a trading port by the capital) and St. Petersburg the leading shipments are wheat, hemp, flax, deals, spars, lathewood, isinglass, and bristles. From Riga come deals and fir-sleepers, most of which go to Grimsby. Memel is noted for its red deals. Danzig, Helsingfors, and Abo are also chiefly occupied in deals, the long deals from Danzig being specially prized for laying decks with. The ports of Stockholm and Gefle, being situated in the mining districts of Sweden, ship iron and copper. The route from Stockholm to England, a distance of 1,130 miles, is by way of the Sound and the North Sea, from five to six days being the usual time taken by steamers, six weeks being the ordinary time taken by sailing ships.

Deals—so far at any rate as bulk is concerned—form the main element in the Baltic trade. They are prepared in the pine forests that clothe the surrounding regions; and from May to November, day after day, the quaint craft that bring them over may be seen entering our ports or lying in our rivers. They are easily distinguished by the ever present windmill, rendered necessary to drive the pump. As they carry timber there is little danger of their sinking; and a leaky vessel, though it lets in water, may also be regarded as letting in ballast at the same time. The refuse resulting from the making of the deals is also sent over here to be used for firewood, and the refuse of the firewood preparation is made into wood pulp to be made into paper; the sawdust again being economised as fuel for the saw-mill. The forests whence these vast supplies of timber are drawn are, for the most part, in the hands of the Government, the revenue from them being devoted to meet the public expenditure.

From the ports on the Norwegian coast further supplies of timber are sent; to the north of Drontheim, however, the prevailing industry is the curing of fish, and this then becomes the staple export. Hamburg is one of the most important of the North Sea ports, and thence comes every variety of foreign manufacture and produce. The chief Dutch ports are Amsterdam and Rotterdam; there is also a considerable transit of Dutch goods in barges as far as Flushing. Belgian produce comes *viâ* Ostend, and is specially noteworthy on account of the great quantities of rabbits which are named from the port of shipment. Another item in this trade is the stallions sent over here for breeding heavy cart horses. The eggs and butter from France are shipped at St. Malo to Southampton, and so good is the service between these ports for this particular trade in perishable goods that produce offered for sale in the markets of Brittany and Normandy on one day may appear on London breakfast tables on the following day.

II. Coming now to the ports of South Europe, and beginning with the most distant, we find that what the Baltic does for North Germany, North Russia, Finland, and Sweden, the Black Sea does for Roumania, Southern Russia, and the north of Asia Minor. The great wheat ports here are Varna, Kustendje, Odessa, Nicolaieff, Taganrog, Marianopol, and Berdiansk. The interior of the country on the north side of the Black Sea is covered with a rich black soil which yields rich crops for little outlay. The port of Batoum has recently become the centre of a great oil trade. After being refined at Baku, where the petroleum springs are situated, the oil is sent by train to Batoum, where it is shipped in steamers specially appointed for this class of trade. The waste products from the refineries are sent up the Volga and used as fuel for steamers. The Black Sea trade is carried on in large steamers, which proceed through the Bosphorus and Dardanelles into the Mediterranean, thence through the Straits of Gibraltar into the Atlantic. The distances to London are from Odessa 3,410 miles, from Taganrog 3,680, and from Batoum 3,670. Besides wheat, which is the staple export, large quantities of other cereals are shipped in the Black Sea, also tallow, hemp, caviare, hides, and tobacco.

Of Mediterranean ports the chief in the dried fruit trade is Patras—in fact, this, with oil and sponges, is the prevailing export from Greece. From the Turkish port of Salonica come occasional cargoes of grain. From Venice *viâ* the Adriatic Sea fancy articles, especially in beadwork, are sent. The Venetian women have a skill in this that is unrivalled, and yet they earn only 3d. per day! Thus it pays to send beads from London to Venice to be there put together, the finished work being sent back to London again. The Sicilian ports of Messina and Palermo send us salt, sulphur, and wine, and with Southern Italy olive oil. From Leghorn and Genoa comes the best quality of walnut wood, used for making musket stocks, and lamb-skins to be made into kid gloves! It may be worth observing here that skins imported into this country are seldom sold under their proper designations. Besides the lamb-skins just referred to as supplying kid, another instance occurs to us in the sheep-skins of South Africa. These are usually sold here as dog-skins. They are not woolly as our sheep are, but hairy like a dog. We refer to the native sheep—the big-tailed sheep of South Africa, as it is called.

Proceeding round the French shore of the Mediterranean, we reach the Gulf of Lyons, a name that immediately suggests silk. From the east or Mediterranean side of Spain come raisins and other dried fruits, wines, tomatoes, and grapes. In the south of Spain is grown the sweet grape that yields sherry, while north of Barcelona, which is the Manchester of Spain, is grown the French grape. At the Portuguese port of Setubal are produced large quantities of salt, some of which reaches England by accident. On the sea-shore here are dug extensive shallow reservoirs which are filled by the tides. The heat of the sun evaporates the water, and all the labour required is to collect the salt, which is sent by ship to Norway to cure fish. On the way there salt-laden boats, which have to pass our shores, sometimes meet with accidents and put into our ports for repairs. The salt is then sold for whatever it will bring, as its value is too little to bear the cost of reloading. From the north coast of Spain, where the chief port is Bilbao, come the finest metal ores. These are mixed with our own metals and produce the finest quality of steel. This part of Spain comprises the Basque provinces, and was in the days of Rome the seat of iron manufacturing. The inhabitants are quite distinct from the other inhabitants of Spain, speak a distinct language, and are supposed by some to be of the same race as the ancient Etruscans. The Basque provinces recall by contrast the southern shore of the Mediterranean, once the granary of ancient Rome. This district now yields little except esparto, which grows wild. It is shipped from Svax in Tunis for paper-making. Among other Continental ports between which and this country constant communication is kept up, but which call for no special mention, are Oporto, Bordeaux in the wine-producing part of France, Havre, and Calais.

III. The ports for the north-west of Africa, from which we receive beans and grain, are Mazagan and El Arish. These being in Morocco, where the Sultan is supreme, the trade is irregular, the Sultan stopping it and allowing it just as he pleases. Along the coast of Guinea are the ports whence comes the palm oil. This useful product is floated down the rivers in canoes and launches to the coast, these rivers thus receiving the name amongst traders of the "oil rivers." As regards South Africa, the bulk of the trade is carried on by steam, and a regular service, both for passengers and produce, with magnificent steamers, is provided by the Castle Line and the Union Line. Sailing vessels do a coasting trade, bringing produce from the smaller ports to Cape Town, Port Elizabeth, East London, and Durban. At these points the produce is collected and sent farther afield by steam. In a similar way the railways feed the ports, the railways in turn being fed by trek oxen. In this way are gathered together the wool, mohair, hides and skins, ostrich feathers, copper ore, and other products of the interior and outlying districts. The liners after leaving England touch at Lisbon, Madeira, Canary Islands, St. Helena, and Ascension, at some of which places the vessels are coaled and cargo and passengers landed or taken on board. The distance from London to Cape Town is 6,242 miles, and the time taken by a liner is from seventeen to twenty days. Sailing vessels take as long as sixty days.

On the east coast of Africa the most important trading centre is Zanzibar, which with Delagoa Bay is in direct cable communication with England. Its chief export is cloves. It has also nine-tenths of the whole ivory trade, which is brought from the interior. A weed is also collected from the rocks on the coast here, a species of lichen named orchilla, and is used in dyeing skins and leather. Other of its exports are gold, silver, iron, malachite, sesame seeds, wax, oil, sago, arrowroot, tortoise-shell, and indigo. Steam vessels are employed in this trade, and come by way of the Red Sea and Suez Canal. Following the East African coast northwards we come to Egypt, whose produce is shipped from Alexandria, and comprises chiefly raw cotton and cotton seeds, cereals, wool, and onions. These, of course, come by way of the Mediterranean and Straits of Gibraltar.

LATIN.—XLII.

[*Continued from p.* 296.]

LATIN READINGS (*continued*).

PLAUTUS.

As a specimen of the powers of Plautus in a more serious vein, we print from the same play the thanksgiving of Charmides to Neptune for his prosperous voyage:—

TRINUMMUS, ACT IV., SC. 1, l. 1—8.

CANTICUM.—CHARMIDES.

Salsipotenti et multipotenti Jovis fratri aetherei,
Neptuno,
Laetus lubens laudes ago, et gratis gratas habeo,
et fluctibus salsis,
Quos penes mei fuit potestas, bonis meis quid foret
et meae vitae,
Quom suis me ex locis in patriam urbis tutelam
reducem faciunt.
Atque ego tibi, Neptune, ante alios deos gratis
ago atque habeo summas.
Nam te omnes saevom, severum atque avidis moribus commemorant,
Spurcificum, immanem, intolerandum, vesanum.
Ego contra opera expertus.
Nam pol placidum te et clementem eo usque
modo, ut volui, usus sum in alto.

NOTES.

Ætherei. The epithet is applied to Jupiter as "King of Air," in opposition to *Salsipotens*, "King of the Deep."

Gratis gratas—"grateful thanks" (*grates*).

Quos penes, etc. "Who have had it completely in their power to determine what should be the fate of my goods and myself." *Penes fuit mei potestas* is a somewhat tautological expression; lit., "in whose hands was the dominion over me."

Patriam urbis tutelam, "my country and the protection of the city."

Ago atque habeo, "I express and feel."

Saevom Old spelling for *saevum*

Opera. "By actual fact, by experience."

Pol. A short form of the more common *Edepol*, "by Pollux," a frequent oath.—*Eo usque modo ut volui*, "exactly in the way in which I wished."

TERENCE.

P. Terentius Afer flourished some years after Plautus, from whose comedies you have already read extracts, and whom he excelled in greater purity of diction and finish of style, though he cannot be credited with greater originality than his predecessor, being even more dependent than he upon Greek sources for the form of his plays, the outlines of their plots, and the names and individuality of his characters. He is said to have lived at the end of the Second Punic War, and to have been a Carthaginian slave, which latter statement is borne out by his name, Afer (the African). He is only known to have written six plays, all of which have come down to us, and which bear the following titles—"Andria," "Hecyra," "Eunuchus," "Hautontimorumenos," "Adelphi," "Phormio." It is needless to give in detail the plots of any of these; they none of them give a high idea of the morality of the age, and principally turn upon lovers' intrigues, the father's wrath—a serious thing in a country where the father was allowed absolute control over his children—and the shifty machinations of ingenious slaves, whose cunning, if not always successful, is generally the most amusing element in the piece.

A few words are necessary to explain the following extract from the "Andria." Pamphilus, son of Simo, has fallen in love with Glycerium, a native of the isle of Andros—hence the title of the play. His father, hearing of it, and thinking the marriage not likely to be a very creditable connection, orders him to marry the daughter of his old friend Chremes. Davus, the slave of Simo, who has a plot in his head for setting matters right, induces Pamphilus to profess submission, and it accordingly becomes known that Pamphilus is to marry the daughter of Chremes (Philumena), with whom Charinus, a friend of Pamphilus, is already in love; and Byrrhia, the slave of Charinus, has just informed him of the report.

ANDRIA, ACT II., SC. 1, l. 2—28.

CHARINUS. BYRRHIA. PAMPHILUS.

Ch. Va misero mihi.
Ut animus in spe atque in timore usque antehac adtentus fuit,
Ita postquam adempta spes est, lassus, cura confectus stupet.
By. Quaeso edepol, Charine, quando non potest id fieri, quod vis,
Id velis quod possit. Ch. Nil volo aliud nisi Philumenam. By. Ah,
Quanto satius 'st te id dare operam, qui istum amorem ex corde ejicias;
Quam id loqui, quo magis lubido frustra incendatur tua.
Ch. Facile omnes, cum valemus, recta consilia aegrotis damus.
Tu si hic sis, aliter censeas. By. Age, age, ut lubet. Ch. Set Pamphilum
Video. Omnia experiri certum 'st prius quam pereo. By. Quid hic agit?
Ch. Ipsum hunc orabo: huic supplicabo: amorem huic narrabo meum:
Credo impetrabo, ut aliquot saltem nuptiis prodat dies
Interea fiet aliquid, spero. By. Id aliquid nihil est. Ch. Byrrhia,
Quid tibi videtur? adeon' ad eum? By. Quid ni? nihil ut impetres,
Ut te arbitretur sibi paratum moechum, si illam duxerit?
Ch. Abin' hinc in malam rem cum suspicione istac, scelus?
Pa. Charinum video. Salve. Ch. O salve, Pamphile,
Ad te advenio, spem, salutem, consilium, auxilium expetens.
Pa. Neque pol consili locum habeo, neque ad auxilium copiam.
Set istuc quidnam 'st? Ch. Hodie uxorem ducis? Pa. Aiunt. Ch. Pamphile.
Si id facis, hodie postremum me vides. Pa. Quid ita? Ch. Ei mihi,
Vereor dicere: huic dic quaeso Byrrhia. By. Ego dicam. Pa. Quid est?
By. Sponsam hic tuam amat. Pa. Ne iste haut mecum sentit. Ehodum dic mihi:
Numquidnam amplius tibi cum illa fuit Charine? Ch. Ah, Pamphile,
Nil. Pa. Quam vellem. Ch. Nunc te per amicitiam et per amorem obsecro,
Principio ut ne ducas. Pa. Dabo equidem operam. Ch. Set si id non potest,
Aut tibi nuptiae hae sunt cordi. Pa. Cordi?

NOTES.

Edepol. A form of oath, used merely to intensify a remark (lit. "by Pollux"); frequently the monosyllable *pol* is used.

Quoniam id, etc. "Since what you wish for is an impossibility, that you would make up your mind to possibilities."

Tu si hic sis. "If you were in my condition you would think differently."

Age, age, ut lubet. A simple form of acquiescence. "Well, well, as you will."

Sed Pamphilum. Here his supposed rival appears on the stage.

Quid hic agit. This is said by Byrrhia in an "aside." "What does he mean by making every attempt?"

Credo impetrabo. "I trust I shall obtain from him." This is of course a construction not allowable in good Latin. The natural construction would be *credo me impetraturum esse.*

Id aliquid. "That something he talks of means nothing."

Adeone. A sort of deliberative present which seems to point to a nearer object than the future, *adibo.*

Scelus. For *sceleste.* "Scoundrel."

Charinum. Pamphilus at this point catches sight of his friend.

Pol. See note on line 5.

Haut mecum sentit. "His taste differs from mine."

Quam vellem, sc. *fuisse.* "How I wish there had been."

Tibi sunt cordi. *Cordi esse alicui* means "to be pleasant to anyone." Pamphilus contemptuously repeats the word, "pleasant indeed!"

In the following extract, taken from the "Phormio," Demipho—whose son, Antipho, has married without his father's consent—gives vent to his indignation, to the amusement of Phædria, his nephew, and the slave Geta, who are overhearing him unseen, and throw in an occasional "aside."

PHORMIO, ACT II., SC. 3, l. 1—16.

DEMIPHO. GETA. PHAEDRIA.

De. Itane tandem uxorem duxit Antipho injussu meo?
Nec meum imperium: ac mitto imperium: non simultatem meam
Revereri saltem? non pudere? O facinus audax, O Geta
Monitor. Ge. Vix tandem. De. Quid mihi dicent? Aut quam causam reperient?
Demiror. Ge. Atqui reperi jam: aliud cura. De. An hoc dicet mihi?
Invitus feci; lex coegit? Audio. Fateor. Ge. Places.
De. Verum scientem, tacitum, causam tradere adversariis,

Etiam idne lex coegit? GE. Illud durum. PH. Ego expediam: sine.
DE. Incertum 'st, quid agam; quia praeter spem, atque incredibile hoc mi obtigit;
Ita sum irritatus, animum ut nequeam ad cogitandum instituere.
Quamobrem omnes, cum secundae res sunt maxume, tum maxume
Meditari secum oportet, quo pacto advorsam aerumnam ferant.
Pericla, damna, exilia peregre rediens semper cogitet,
Aut fili peccatum, aut uxoris mortem, aut morbum filiae:
Communia esse haec: ne quid horum umquam accidat animo novom.
Quicquid praeter spem eveniat, omne id deputare esse in lucro.

NOTES.

Itane tandem. An expression of surprise and indignation. "What forsooth?"

Imperium. The vow which denoted supreme military power is here to signify the absolute control, *patria potestas*, given by the Roman law to a father over his own son, which amounted even to a power of life and death.

O Geta monitor! Apostrophising the slave whom he thinks absent, and to whom he entrusted the care of his son. "O Geta, a fine mentor, truly" The slaves were frequently called by the name of the tribe from which they had been taken. *Geta* is one of the *Getae* or Thracian tribe on the Danube. *Davus* is said to be the same word as *Dacus*, one of a tribe inhabiting the modern Transylvania.

Vix tandem. The slave, hearing his name mentioned, remarks aside. "At last he has thought of me." Supply *mei meminit*.

Aliud cura. Lit. "Think of something else." "Make your mind easy."

Causam tradere, etc., "to allow oneself to be beaten."

Illud durum. Phædria feels that this is an unanswerable argument, but Geta consoles him with the remark, "I'll get over it; leave it to me."

Spem is used to signify the reputation of evil as well as the hope of good; so Dido in Virgil, "Æneid," iv. 419, says:—

> "Hanc ego si potui tantum sperare dolorem."

Peregre rediens. "Returning from foreign travel."

Ut ne, used with *quid*, to follow, signifies a purpose negatived.

Deputare. "To write all that down as profit."

KEY.

PLAUTUS, "TRINUMMUS," ACT IV., SC. 1.

CHARM. To Neptune, potent o'er the deep and most powerful, the brother of ætherial Jove, joyously *and* sincerely do I proffer praise, and return my grateful thanks; to the salt waves, too, with whom lay *supreme* power over myself—*one, too*, that existed over my property and my life,—inasmuch as from their realms they have returned me *safe* and sound even to my own native city. And, Neptune, before the other Deities, do I both give and return to you extreme thanks. For all people talk of you as being cruel and severe, of voracious habits, filthy, unsightly, unendurable, *and* outrageous; on the other hand, I have experienced your *kindly* aid. For, in good sooth, I have found you merciful upon the deep, even to that degree that I wished.

THE ORGANS OF SENSE.—V.

(Continued from p. 306.)

III.—THE ORGAN OF SMELL *(continued)*.

ONE great service which the sense of smell renders to the higher animals—*i.e.*, to beasts, birds, and reptiles—is primarily to warn them against receiving into the lungs and stomach noxious matters, and secondarily to guide them in the search for wholesome air and food. As a rule—to which, however, there are many exceptions—nauseous smells are associated with noxious gases, and food which gives off a pleasant aroma is of a nature, and in a condition, to supply good nutriment. The bulk of the atmosphere consists of inodorous gases, admirably mixed so as to suit the purposes of respiration, and the main products of vegetable life are nutritive and bland; but small quantities of destructive effluvia and of deadly poisons are no uncommon things in nature, and unless some kind of quarantine were exercised on air and food, the system could not be maintained in health. True, therefore, to its office of sanitary inspector, the organ of smell holds a position at the entrance of the passages for air and food. In order to appreciate its office, it is necessary to understand the relation of these passages to one another. This is best done by a reference to the illustration (Fig. 9). The largest figure represents the nose chamber of the left side; the hollow of the mouth below it; the pharynx, or channel for food, running down towards the stomach on the left side (of the figure); and the larynx, or channel of the air, when pursuing its course to the lungs, parallel to it, on the right-hand side, as they would appear if the head were cut in two with the downward stroke of a sharp resistless knife, made as near to the middle plane as possible, yet so as to be on the left of the upright partition between the two nose-chambers. The ordinary course of the air, when no food is being swallowed, is upward through the nostril, then horizontally through the lower part of the nose-chambers, then downward and forward behind the soft palate, entering the hole immediately below the part marked as the "epiglottis," and so on to the lungs. The simpler course of the food is horizontally through the mouth, and then vertically downward. If the reader has understood the engraving, he will see that the air and food passages cross one another; or, perhaps it makes it more clear to say that the air passage enters the food canal from above, and passes out again below and in front of it. This is a singular arrangement, and open, one would have said, to the obvious objection that the food might get into the lungs, where it is not only not wanted, but could not be for a moment endured. This catastrophe is, however, provided against by the act of swallowing, in which the soft palate closes the air entrance above, and the epiglottis is bent down, while the sides of the hole below are so contracted beneath its overhanging and protecting hood, that the food passes over it, and the drink on each side of it, without danger of their making an entrance into the larynx. It will be seen that the effluvium from food not only rises into the nasal organ when it is presented to the mouth, but passes to it also after it has been introduced into the mouth, so that the nose is an effective guard to this entrance, as well as to that which it more immediately occupies.

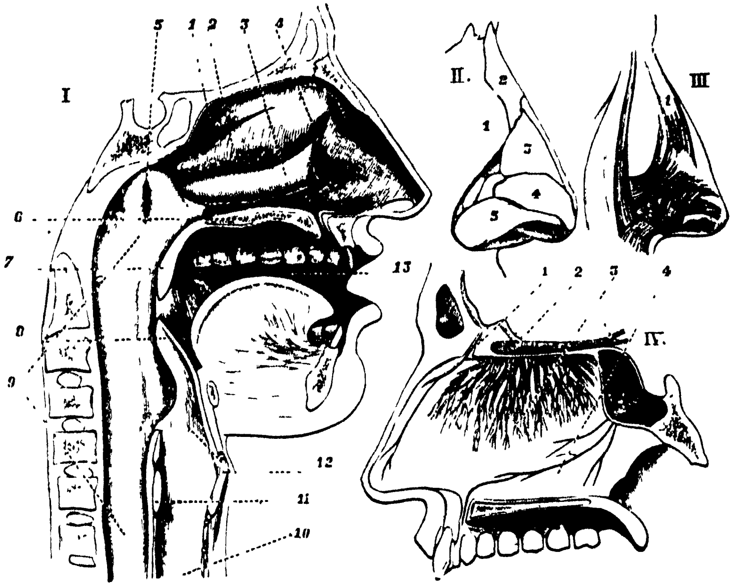

Fig 9.—I. Vertical Section of Human Head, showing the Relation of the Passages for Air and Food. II. Framework of the Nose. III. Muscles of the Nose. IV Septum of the Nose and its Nerves.

Ref. to Nos. in Figs.—I. 1, upper turbinated bone; 2, middle do.; 3, lower do; 4, hole leading to the canal which drains the eye; 5, Eustachian hole, 6, palate; 7, uvula; 8, epiglottis; 9, pharynx; 10, larynx; 11, cricoid cartilage; 12, thyroid cartilage; 13, cavity of the mouth. II. 1, part of upper jaw bone, 2, nose bone; 3, upper side cartilage; 4, lower do.; 5, cellular tissue. III. 1, pyramidal muscle of the nose; 2, muscle to lift the side cartilages; 3, compressor of the nose; 4, front dilator of the nostril; 5, small compressor of the nostril; 6, hind dilator of the nostril, 7, muscle to pull down the side cartilages. IV. 1, nerve of the lobe of nose; 2, olfactory lobe of brain; 3, nerves of the septum; 4, nerve of palate.

The external protecting framework, or nose, covers in the nasal chambers in front, and, on account of its oblique direction, overhangs the orifices, which are further defended from intrusive solids by a number of stiff hairs. At the upper part, or roof of the nose, this framework is of bone, because there no flexibility is required, but towards the point it is composed of cartilages, which are more elastic, and which can also move in relation to one another, while the outer and lower sides of the orifices are composed of yet more bendable cellular tissue. These wings of the nose can play up and down, and to and from, the central partition by the action of muscles, so as to enlarge, contract, or slightly alter the direction of the openings; but the framework is, nevertheless, stiff enough to keep the nostrils moderately distended while in a state of rest. Stretching horizontally backward from the nose are the nasal chambers, divided from one another by a plain partition, which is bony behind and gristly in front, and they pass under the chamber of the brain and over the cavity of the

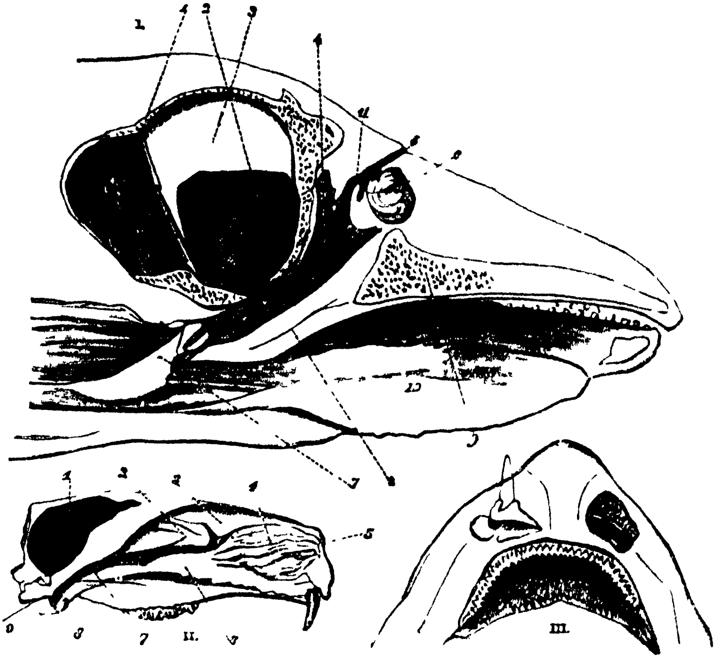

FIG. 10.—I. VERTICAL SECTION OF HEAD OF PORPOISE, SHOWING THE NASAL PASSAGE. II. VERTICAL SECTION OF RABBIT'S HEAD, SHOWING OUTER WALL OF THE NASAL CANAL, LEFT SIDE. III. UNDER SIDE OF HEAD OF SPOTTED DOG-FISH

Refs. to Nos. in Figs.—I. 1, 2, cavity of the skull almost divided into two; 3, septum between the right and left halves of the brain; 4, nasal passage; 5, slit-like orifice; 6, folded membrane; 7, upper end of air-passage, grasped by the sides of the nasal canal, 8, soft palate; 9, hard palate; 10, tongue; 11, valve. II. 1, cavity of the brain; 2, 3, ethmo-turbinals; 4, lower turbinal; 5, nostril; 6, palate; 7, nasal canal; 8, bulla of ear; 9, bristle running through Eustachian tube.

mouth, to open backward over the throat. Solid floors of bone divide this second storey of the head from the upper and lower rooms, and bones also wall in the right and left sides. These walls, however, are not smooth and plain like the central partition, but have three bony projections one above the other, which are called turbinated bones, because they are curled upon themselves like scrolls, the first convex surface of the scroll being directed inwards. These turbinated bones stretch inwards, nearly reaching the plain partition, and thus divide each lateral chamber into three horizontal passages, called the upper, middle, and lower passages. All the interior of the chambers is covered with a membrane, which is very thick and pulpy on the scroll bones, the roof of the chamber, and central partition. This membrane is peculiar in that it secretes a slimy mucus, is very vascular, and so contains much blood, and the ultimate fibres of the nerve of smell end in its substance. The nervous apparatus of smell on each side arises from under the brain by three roots; it is in the shape of a little round horizontal bar of brain matter, ending in a bulb, and it lies in a groove of the soft brain above, and of the hard bone beneath, being separated from its fellow by a crest of bone. These bulbs being placed in the brain-case, send down, from all along their course, through many holes in the bones on which they lie, nervous cords, which divide and subdivide, and run, some to the vertical central partition, some to the top scroll-bone, and some to the roof of the chamber. Their distribution, of course, indicates where the sense of smell resides, that is, not in the main channel of the air, which passes along the floor of the passage, but in the upper part of the chamber. Hence, when we want to smell anything, we take means to get the gas driven upward into the upper part of the nose. This is effected by contracting the nostrils, and drawing the air suddenly and sharply in, so that it is directed upwards instead of along the floor of the passage.

It has been remarked that the membrane of the nose is very full of blood-vessels, and this is important, because the presence of much warm blood distributed over a surface purposely folded to give it a greater extent, has a tendency to warm the cold air as it passes through the complicated channels before it is introduced into the lungs. That cold air, introduced through the nose instead of through the mouth, is less likely to be injurious, is so far recognised, that respirators are used by delicate persons in cold air, while it is not thought necessary thus to protect the nose. Some of us need to be reminded that we should breathe always by our nose and not by our mouth.

There are curious connections between the nasal chambers and the hollows in many of the bones of the face and head, which are analogous to the air cavities of birds' bones. The nose has also another office, in that it serves as a sewer for the eye. Two little ducts from the inner corner of the eye join and form a tube, which, after passing through a bony canal, delivers its drainage into the lower meatus of the nose by a small orifice, shown in the engraving. Hence, violent blowing of the nose is often resorted to in order to clear the eye from dust and tears.

So far as concerns ourselves, the use of the olfactory organ is rather to teach us what to avoid than what to seek, and the pleasures of smell are rather incidental to other healthful conditions than much prized on their own account; yet the varied fragrance of a thousand flowers, so delicately diffused as not to pall the sense, or to surcharge the pure air, is no small addition to the delights of the garden and the country. If, however, we endeavour to imprison these odours, and make them our own, they are nearly always suggestive of a sickly effeminacy, and have called down sneers on their possessors. Thus, Cowper writes—

> "His better hand, more busy, gives the nose
> Its burgamot";

and Tennyson—

> "His essences turned the live air sick";

and again Shakespeare—

> "He was perfumed like a milliner."

It is curious to note that no sensation brings back scenes to our mind in so lively a manner as do odours long unsmelt; a whiff of water containing sulphuretted hydrogen gas may serve to remind a middle-aged man of the days when he began to learn analytical chemistry.

To us the sensations of smell are far less vivid and reliable than those of sight and hearing, or even those of touch and taste. They furnish but few starting-points for thought, or speculation, or reason to proceed from. We seldom employ the smell in investigation, unless it be upon objects which give no indication whatever to any of the other senses; and when we do so we are not satisfied until we have other confirmatory evidence as to the nature of those objects. The chemist in the laboratory will make use of this sense as a rough-and-ready method of detecting gases which cannot otherwise be easily dealt with, but he always confirms their presence by other tests if possible. Anyone who has presided over the practical experiments of students in chemistry will have been struck with the number of men whose sense of smell is imperfect and unreliable; and even those who think they have this sense unimpaired are often misled, from the fact that they are conscious of a sensation, not produced by odour, but which is, in fact, only the general sense of touch, common to the surface of the body, and only more acute in the delicate lining membrane of the nose. Such students can detect pungent gases like ammonia and chlorine, but cannot distinguish between them, or between aromatic gases like alcohol and chloroform. On the whole, we make such little use of our organ of smell, its acuteness being as often an inconvenience as an advantage to us, that we endure the loss of this sense with more patience and with less sense of privation than that of any other. The estimate we form from experience of the comparatively small value of this sense is apt to make us misjudge its importance to the lower animals. But if we imagine that the impressions which this sense brings to animals are as dull, indistinct, and unreliable to *their* consciousness as to ours, a little observation of the habits of animals will soon lead us to suspect our error. The sense seems to be the keenest in the carnivora, and man is so sensible of his inferiority to these in the sense of smell that he supplements his deficiency by their acuteness. The little terrier will inform his master, the rat-catcher, if the rat is at home by his impatient scratching at the mouth of the hole. The huntsman sees a fox cross an alley in a wood; Reynard has gone he knows not whither, and has left no trace which is available to his dull sense. But a hound comes in sight, and when motioned to the place he sniffs the ground in uncertainty but for a moment, and then flings up his nose towards the sky, and with one long melancholy howl calls his comrades of the pack, and, in almost less time than it takes to write it, they are all in full cry on the trail, making the echoes ring with their confident music. Who has not observed the pointer, as he stops in the midst of his swift business-like beat, motionless, as if

Medusa's head had turned him to stone? Yet, if you mark him well, his whole frame is instinct with tremulous emotion; his eyes glisten, and seem starting from his head; his nostrils twitch, and his limbs quake with excitement. The game lies hidden in deep cover; it is impossible for him to see it; but as you look at him you feel certain that he is as vividly conscious of its presence as if his eye saw or his foot were upon it.

We have seen, in writing of the other senses, that while beasts seem to have these in greater efficiency than men, this is because their attention is not abstracted from their indications, and not because the organ is any more perfect or elaborate in its structure; but in the case of the smell, a corresponding development and complication of structure accompanies a keener sense. The great difference between the skull of man and that of the beast consists in the fact that in the latter the brain and the brain-case—which it accurately fits—are much smaller; the jaws—and therefore the hollow of the mouth—are much larger and longer. Now the nasal cavity which lies between these partakes, in the beast, of the elongation of the jaws, and not of the curtailment of the brain. The nose is almost always at the end of the muzzle, and the long chambers of the nose only pass under the brain at the posterior part of their course, where they also begin to descend to enter the throat. Hence, instead of comparing the face to a three-storeyed house, as we did in speaking of the man, it should be compared to a two-storeyed shed, with a lean-to behind for the accommodation of the brain. The turbinated bones are, therefore, not so much one above as one behind the other, the front or inferior one being very much enlarged and contorted, or folded, so as to fill up the large chamber. This bone is very differently shaped in different animals. In the sheep it arises by a broad plate, which runs inwards from the outer wall of the nose, and then divides into two plates, both of which assume the form of scrolls, one curling upwards and the other downwards; and the number of turns of these scrolls is so great that if a transverse section of the nose be made, the edge of the bone looks like the capital of an Ionic column. In the hare and rabbit the bone has a different form, and consists of a number of plates one above the other, which subdivide into other smaller horizontal plates or ridges, all of which are, so to speak, gathered together into one stem at each end. The seal has a bone of the same structure, but much more subdivided and complicated; and the extraordinary development of the organ in these swimming carnivora would lead us to suppose that they hunt by scent. It will be seen that the design of all these structures, however different their form may be, is to increase the surface over which the pituitary membrane, as it is called, can be spread. Now, in man, the membrane of the lower scroll-bone is not so specially the seat of the organ of smell as of a refined and acute organ of touch; for the nerve which supplies it is not from the olfactory bulb, but from the fifth pair of nerves. It is this nerve which is excited by the application of snuff; so that the snuff does not act as an odour, but as an irritant, and the pleasure may be compared, by those who do not appreciate it, to the pleasure of scratching in other parts of the body. In beasts, however, the turbinated bones are not one above, but one behind the other, and the air passes successively over them all, instead of below the ethmo—or upper turbinated bones as in man.

Perhaps it is not out of place here to remark upon some functions discharged by the nose which are not olfactory. In the porpoise the brain has no olfactory lobe, and there are no olfactory nerves; and therefore the nasal passages are made subservient to the supply of the lungs with air. A reference to the engraving (Fig. 10, I.) will show how the canal from the slit-like opening at the top of the head passes down past a valve, which closes it against the water when the animal is submerged, and then onward to the head of the windpipe, which here does not open on the floor of the œsophagus (or food-throat), but is continued up and thrust into the nasal canal, while the muscles of the soft palate and food-throat grasp it firmly.

The hog uses his disc-shaped snout to turn up the earth, and the tapir curls his flexible nose round the grass to tear it up; but these slight differences from the usual development of the organ sink into insignificance beside the enormously elongated trunk of the elephant. In this beast the two narrow tubes into which the nasal chambers are continued forward, run to the very end of the organ, where there is, on the upper side, a finger, as it were, which seems to be as serviceable as any of our own. Strong bundles of muscles run along the trunk on all sides, and radiating ones pass between these, so that the beast can move his trunk in any direction he pleases.

LIGHT.—V.

[*Continued from p. 301.*]

PRODUCTION OF AN IMAGE WITH THE FLASK OF WATER.

We may now proceed a step farther with our investigation of the optical phenomena presented by a flask of water. Only part of the light which falls upon the flask is sent back; some of it passes through. The latter may be made to give an account of itself in the following interesting manner:—Behind the flask *f* place a stiff paper screen *s*, which may be held upright between the leaves of a book. Put a candle at *c*—say, about a foot away. The light which passes through the flask forms itself into an image *i*.

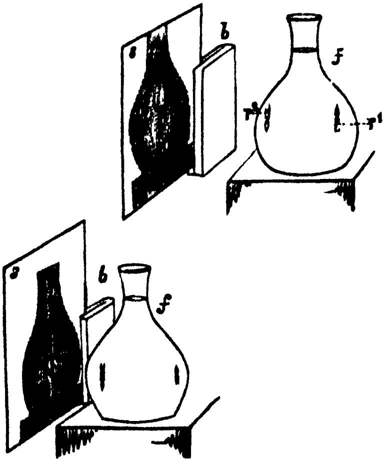

Fig. 41.

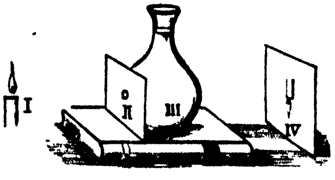

Fig 42.

Observe, firstly, that the image of the candle is inverted; and, secondly, that if the distance of the light from the flask be increased, the position of the screen has also to be altered; thus, with the candle at *c'*, we have to move up the screen to *s'*.

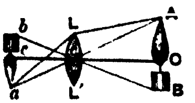

Fig. 43.

And, further, that we can increase the distinctness of the image by cutting off all marginal rays, which may be done by interposing between the light and the flask an opaque sheet with a round hole in it, as at II (Fig. 42). All the above experiments may be done more perfectly with a double-convex lens, which is thicker in the middle than at the rim, and is drawn in section in Fig. 46. When such a lens is held in sunlight the solar rays are converged to a point *f*, called the principal focus, and it is here where the image is formed for parallel rays like those of the sun. Now place a candle at a greater distance from the lens than the distance of the principal focus, and place a white screen of paper on the other side of the lens; an image of the candle will be cast on the screen. Fig. 43 will explain the formation of the image. The focus of each ray passing through the lens from the object is somewhere in the line drawn from the point in the object whence the ray emanates through the centre of the lens L L' to the other side of it. Thus, if *c'* represent the centre of the lens, the point of light A has its focus somewhere in the line A C' *a*, and the point of light C has its focus somewhere in the line C *c'* *c*. Hence, if we trace the path of some other ray from the given point through the lens to where it intersects the line drawn through the centre, we shall have its position in the image; thus, the ray A L is refracted in the direction L *a*, and at the point *a* it intersects A C' *a*; *a* is the tip of the image of the object A B. The reader may exercise himself in finding out how the rest of the image, *a b*, is formed.

THE DOUBLE-CONVEX LENS IN THE EYE.

A much more remarkable lens than any of human construction is that which exists in the eye. The eye may be regarded as a spherical box packed with a transparent jelly V (Fig. 44), and with a lens *l* held in position by suitable muscles. In front of the lens is an annular curtain of green or blue, etc., and in front of this, again, a watery liquid in a cavity formed between the lens

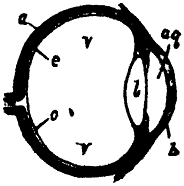

Fig. 44.

and a transparent bulging front called the cornea, *b*. Light from without passes through the cornea, aqueous humour, *aq*, to the lens *l*, by which it is refracted and cast on to the back of the eye as a picture of external objects. The concave purple screen upon which this image is cast, at the back of the eye, is termed the retina, and its impressions are carried by the optic nerve to the brain to create the consciousness of sight.

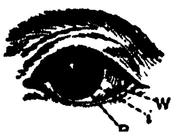

Fig. 45.

All one usually sees of the eye is represented in Fig. 45, where P represents the dark inner circle through which light enters the eye; it is called the pupil. Next we have the coloured ring *i*, which varies in size to regulate the amount of light entering the eye; this is the iris. Surrounding these we have W, the white of the eye. To see what exists inside the eye, procure the eye of a sheep or of an ox, and cut it open; each of the parts we have already mentioned will be found; note particularly the form and nature of the crystalline lens.

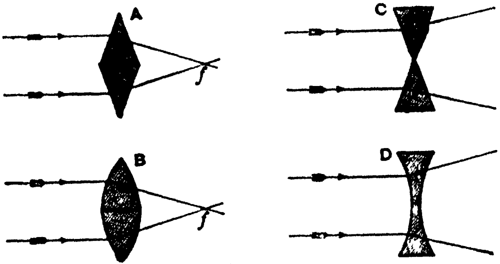

Fig. 46.

The lens *l* (Fig. 44) is unlike the hard breakable materials with which we have carried on our experiments; it is of transparent crystalline organic material, variable in form according to the amount of pulling exerted on it by the muscles which hold it in position. Therein we have a beautiful provision for seeing both near and distant objects with ease; in other words, of always keeping the images of objects on the retina, which is necessary for a clear sight of them. The retina is fixed in position; and, therefore, for near objects the lens assumes its greatest convexity, and for distant objects its least convexity; and this alteration in curvature may even be seen by looking into the eye of a friend, with a candle or burning taper on one side, while he changes his gaze from a distant to a near object. The reflected images of the candle from the front and back surfaces of the lens recede from each other. Hence, it is impossible to see distant and near objects at the same time.

Look at a distant object between the extended fingers; so long as you see it clearly, the fingers are indistinct. Next look at the fingers; the distant object cannot now be made out.

THE ACTION OF LENSES ON LIGHT.

The action of lenses on light becomes, perhaps, more intelligible to the reader if he considers their relation to the prism, which is very apparent on seeing sectional diagrams of them. The similarity of the double-convex lens B (Fig. 46) to the two prisms placed base to base at A, extends also to their action on light; for if parallel rays fall on them in the direction of the arrows, these rays are converged to a focus *f* on the other side. Again, the double-concave lens D, seen in section, is not unlike the view presented at C of two prisms apex to apex; and just as the action of two such prisms on light is a divergent one, causing the rays to spread out, so the double-concave lens has a divergent effect on rays passing through it.

CHROMATIC ABERRATION.

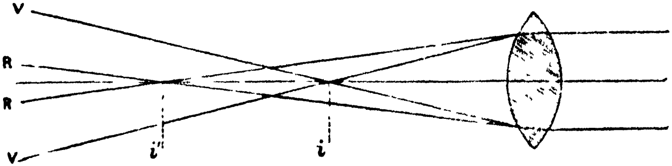

Fig. 47.

The prismatic action of a lens on light is still further shown in the coloured rim which surrounds the circular area it illuminates when rays pass through it and are cast on to a white screen. This may be seen by casting an image of the sun on to white paper by means of a double-convex lens, like a spectacle-glass adapted for long sight. If the paper be between the lens and the focus, the rim is red; but if the paper be placed beyond the focus, the rim is blue. The ray *r* (Fig. 47) in passing through the lens is refracted, and suffers dispersion, the red portion near the lens being outside, and the violet portion being inside; hence, in this region the light has a red border. After the rays have crossed, their positions are reversed, and beyond *i'* the circular area of light has a bluish border. Hence, a ring like Fig 48 to cut off the marginal rays would be of distinct use in eliminating this coloured border. Such a ring is called a "stop" or "diaphragm," and is of frequent use for this purpose in optical instruments. The iris is a stop or diaphragm. The dispersion produced by lenses is spoken of as their *chromatic aberration.*

SHORT SIGHT AND LONG SIGHT.

A person who is short-sighted cannot see things at a distance, and he brings minute objects very near the eyes to see them clearly. The defect arises from the central part of the crystalline lens being too dense, and refracting light so as to form a picture in front of, instead of on, the retina. Spectacles with concave glasses correct the evil.

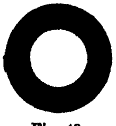
Fig. 48.

In long-sightedness objects are seen best at a distance, and there is a difficulty in reading small type. Here there obtains in the eye an opposite condition of things from those found in short-sightedness. The crystalline lens has a lowered refractive power, so that the images of objects are cast beyond instead of on the retina. The correction to be applied in this case is the use of spectacles with convex glasses in them. Short-sightedness is usually an accompaniment of youth, which may correct itself with increase of years; long-sightedness, on the other hand, begins to show itself in middle-aged and old people. In the accompanying Fig. 49, the action of a short-sighted (A) and of a long-sighted (B) eye is represented, and by the side of each is shown the kind of lens required to correct the defect.

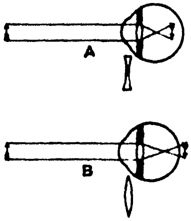

Fig. 49.

THE EYE AS A COLOUR-DISCRIMINATOR.

A large wave breaking on the sea-shore necessarily expends more force than a small wave; a large ether wave breaking on or dissipating itself in the meshes of the retina must also similarly, one would expect, expend more force than a small one. That such differences of mechanical effect do exist has been proved experimentally. The physiological consequences in the individual are a consciousness of differences of colour; thus, while the long ether wave produces the consciousness of red light, the ether wave of half its length appears as a violet light. All the differences of colour we see in a spectrum relate to differences of ethereal wave-length in the undulations which produce them. The wave-lengths of the rays of coloured light have been measured, and, roundly speaking, vary from a thirty-thousandth of an inch to a sixty-thousandth of an inch in length. If we take the ethereal waves which would produce lines of light in the position of the Fraunhofer lines, the following is a more exact statement of lengths, etc.:—

Coloured Ray.	*Colour*	*Number of ether waves in 1 inch.*
A	Red	33,417
C	Orange	38,706
D_1	Yellow	43,131
E	Green	48,205
F	Blue	52,255
G	Indigo	58,971
H_1	Violet	64,011

The power of discriminating between different colours differs very much in people, and even in the same person under certain circumstances. Now, since in the pursuit of certain arts and callings a keen power of colour-discrimination is absolutely essential, it is of importance to know where and when the eye fails in this respect.

There may be such a total lack of discernment of colour-differences that the apple and its leaves appear of one tint, or a solution of yellow bichromate of potash and another of green chromium chloride appear both alike. In such a case, the observer is colour-blind, and ought not to be engaged in any calling where distinguishing between colours is of importance, as in the case of the dyer, or of a railway servant who has to distinguish between signals of different colours. This defect in colour-vision is sometimes called "Daltonism," because Dalton, the famous chemist, was colour-blind to a remarkable degree, and on one occasion is said to have put on red stockings for a Court reception under the impression that they were green.

In advancing years the crystalline lens of the eye may become tinged with yellow, which has a tendency to make blues appear darker than they are. An artist suffering from such a defect would not use his blue pigments in proper quantity when depicting blue or partially blue colours, the tendency being to make them bluer than they ought to be, an effect which is said to be observable in Mulready's later work.

A personal matter which may affect everyone is that of eye-fatigue. Drop some red sealing-wax on to a sheet of white paper, and then steadily stare at it for a minute or two. Next transfer your gaze to another part of the white paper, and you see a faint bluish-green image of the sealing-wax. In staring at the red wax the eye has become fatigued for red rays; in transferring the gaze to the white paper, the eye receives from it all the rays which go to make up white light, from violet to red, but being tired or weakened for the latter it fails to perceive it, the result being that that area of the retina which has been thus weakened does not perceive the paper to be white, but of a colour compounded of the remaining colours of the spectrum. A buyer may similarly stare so persistently at a coloured article that he fails to perceive its true colour; and two reds might be of distinct shades, but with a fatigued eye the difference would not be perceived.

SUBJECTIVE OR ACCIDENTAL COLOURS.

The experiment with the red wafer may be modified by substituting other colours besides red. If orange be used, a blue spectral image is seen; when green is employed, the image seen is reddish-violet. These colours which are seen by a fatigued eye have been termed *accidental*—or, more appropriately, *subjective*—colours. The following is a list of subjective colours seen when a certain colour of object is gazed at:—

Colour of Object.	*Subjective Colour.*
Red	Bluish-green.
Orange	Blue.
Yellow	Indigo.
Green	Reddish violet.
Blue	Orange-red.
Indigo	Orange-yellow
Violet	Yellow-green.
White	Black.

An example of the last mentioned in the list may sometimes be seen under the following circumstances. You are holding something in a gas-flame, and intently gazing at it for a while. When you have done, a black image of the flame may be seen by looking at a sheet of white paper, and winking; when the gaslight is very yellow, the image appears of an indigo tint. This phenomenon always happens when a dazzling light is looked at. The burning of magnesium wire is a common experiment, and after it is over one usually sees a subjective image in black, which is of the shape of a drop of the molten metal, with a short length of oxide attached to it. In the case of the sun a series of images is seen. We mention this, however, only by way of offering a caution. Gazing at the sun is a dangerous experiment, which nearly cost Sir Isaac Newton his eyesight. He was troubled with the subjective images to such an extent that he had to shut himself up in a dark chamber for three days to recover his normal sight.

THE ORIGIN OF COLOUR.

Although we usually speak of the light of the sun as being made up of the seven colours of the rainbow, it requires very little thought (after our experiments with the spectroscope) to see that it really consists of an infinite variety of colours. Every part of the spectrum, however narrow, has in fact a distinct colour of its own; and this line of spectrum by more dispersion may be resolved into parts of less and greater wave-length, and, therefore, of distinct colours, where the difference is inappreciable to the human eye. When this great variety of coloured light falls on to the surface of a substance, it may be wholly or partially sent back or reflected: in the former case the substance is said to be white; in the latter it may be one of an infinite variety of colours. Let us examine more particularly what happens when only part of the light is reflected, and the remainder is kept back—or, in other words, absorbed.

ABSORPTION OF LIGHT.

As we have already seen, the spectroscope enables us readily in some cases to find out what kind of light is absorbed by a substance. Thus, suppose we have an incandescent lamp in front of the slit of our spectroscope, yielding a continuous spectrum from the violet up to the red, our coloured body if introduced between the source of light and the spectroscope robs the light of certain of its constituents, and the spectroscope enables us to find out what part of the light has been absorbed. Let us take a common substance—say, treacle—and put it in a glass vessel, like a thin test-tube, so that light can pass through; we find, on examining the light which has come through with the spectroscope, we get a spectrum in which the violet, indigo, and blue are represented by a dark space—in other words, this part of the light has been kept back, or absorbed; some of the green, yellow, orange, and red pass through, and yield the impression of yellow to the eye. So it is with yellow bodies generally. Those yellow bodies which are not transparent reflect the green, yellow, orange, and red, and absorb the violet, indigo, and blue parts of the light falling on them. The rays which are reflected are received into the eye, and the impression of colour is produced.

MONOCHROMATIC LIGHT.

Salt the wick of a spirit-lamp with common salt. The flame appears golden-yellow, and, in fact, yields only one kind of light—yellow. It is termed monochromatic, which means "one coloured."

If a monochromatic light like this be the only one in a room, some strange effects are observed; thus, no matter how rosy-hued one's face may be, it appears in such a light of a ghastly tint. A stick of red sealing-wax is of the same ghastly yellow, and a crystal of blue vitriol is coal-black. Everything which has not the power of reflecting this monochromatic yellow light appears black or void of colour, and those bodies which do reflect it appear of different degrees of yellow. If the light of the sun were such a one-coloured light, the face of the earth would be a vast monochrome; its non-reflecting surfaces often of a dead black, scarcely distinguishable from shadow, and the green of grass and leaf, the various colours of birds and flowers—would be of a wearisome ghastly one-tint, and there would be entirely absent all that pleasant variety of colour which renders floral nature so charming. With, however, the vast number of different kinds of light which constitute sunlight, and the infinite variety and texture of surface which obtains in the organic and inorganic worlds, we get a wealth of colour, which is a never-ending source of pleasure to the educated eye.

ARTIFICIAL SOURCES OF LIGHT.

Artificial sources of light—like the candle, paraffin-oil lamp, gas-flame, and electric incandescent or arc lamps—all give continuous spectra when examined with the spectroscope. There is, however, in every case a predominance of certain rays, which lend a special character to the light. Thus, for example, when the eye is accustomed to the light of burning gas in street-lamps and shop-windows, an electric arc lamp appears to have a distinctly blue character, and this arises from the relative weakness of gaslight in rays at the violet end of the spectrum and the richness of the electric arc-light in these rays. The gaslight is distinctly yellower than the arc-light, and a tallow candle flame is even yellower than the gaslight. In such lights, therefore, as the candle and gaslight one has a difficulty in distinguishing between shades of blue, as this colour appears more or less black, and minute differences are lost. Colour-matching is, therefore, impossible for certain colours in such lights. Amusing mistakes sometimes occur from this cause A lady in purchasing a piece of ribbon by gaslight selects what she takes to be a piece of the same colour as a small bit she holds in her hand. In daylight, however, it is found that a mistake has been made, as the two pieces of ribbon now appear distinctly different in colour.

SPANISH.—VIII.

(*Continued from p.* 311.)

CONJUGATIONS OF REGULAR VERBS (*continued*).

PARADIGM OF THE THREE CONJUGATIONS (*cont.*).

SUBJUNCTIVE MOOD.

FIRST CONJUGATION.

	Present.		*Perfect Indefinite.*
Sing.	Ame, *I may love.*	*Sing.*	Haya amado, *I may have loved.*
	Ames.		Hayas amado.
	Ame.		Haya amado.
	V. ame.		V. háya amado.
Plur.	Amemos.	*Plur.*	Háyamos amado.
	Améis.		Háyais amado.
	Amen.		Hayan amado.
	VV. amen.		VV. háyan amado.

	Imperfect.		*Pluperfect.*
Sing.	Amára, amaría, amáse, *I would, should, might love.*	*Sing.*	Hubiéra, habría, hubiése amado, *I would, should, might have loved.*
	Amáras, amarías, amases.		Hubiéras, habrías, hubieses amado.
	Amára, amaria, amáse.		Hubiéra, habría, hubiése amado.
	V. amára, amarías, amases.		V. hubiera, habría, hubiése amado.
Plur.	Amáramos, amaríamos, amásemos.	*Plur.*	Hubieramos, habríamos, hubiesemos amado.
	Amarais, amariais, amaseis.		Hubierais, habríais, hubieseis amado
	Amáran, amarían, amásen.		Hubiéran, habrían, hubiesen amado.
	VV. amáran, amarían, amásen.		VV. hubiéran, habrían, hubiésen amado.

	First Future.		*Second Future.*
Sing.	Si amare, *if I should love.*	*Sing.*	Si hubiére amado, *if I should have loved.*
	Si amares.		Si hubiéres amado.
	Si amare.		Si hubiere amado.
	Si V. amáre.		Si V. hubiére amado.
Plur.	Si amáremos.	*Plur*	Si hubieremos amado.
	Si amareis.		Si hubiéreis amado.
	Si amáren.		Si hubiéren amado.
	Si VV. amaren		Si VV. hubiéren amado.

SECOND CONJUGATION.

	Present.		*Perfect Indefinite.*
Sing.	Coma, *I may eat.*	*Sing.*	Haya comido, *I may have eaten.*
	Comas.		Hayas comido.
	Coma		Haya comido.
	V. coma		V haya comido.
Plur	Comamos.	*Plur.*	Háyamos comido.
	Comais.		Hayais comido.
	Coman.		Hayan comido.
	VV. coman.		VV. háyan comido.

	Imperfect.		*Pluperfect*
Sing.	Comiera, comería, comiese, *I would, should, might eat.*	*Sing.*	Hubiéra, habria, hubiese comido, *I would, should, might have eaten.*
	Comieras, comerías, comiéses		Hubieras, habrías, hubieses comido
	Comiéra, comería, comiese.		Hubiéra, habria, hubiese comido.
	V. comiera, comería, comiése.		V hubiéra, habría, hubiése comido.
Plur.	Comiéramos, comeriamos, comiesemos	*Plur.*	Hubiéramos, habriamos, hubiésemos comido.
	Comierais, comeríais, comiéseis.		Hubiérais, habriais, hubiéseis comido.
	Comiéran, comerían, comiésen.		Hubieran, habrían, hubiésen comido
	VV. comiéran, comerían, comiésen.		VV. hubiéran, habrían, hubiésen comido.

	First Future.		*Second Future.*
Sing.	Si comiere, *if I should eat.*	*Sing.*	Si hubiére comido, *if I should have eaten.*
	Si comiéres.		Si hubiéres comido.
	Si comiére		Si hubiére comido.
	Si V. comiére		Si V. hubiére comido.
Plur.	Si comiéremos.	*Plur.*	Si hubiéremos comido.
	Si comiéreis.		Si hubiéreis comido.
	Si comiéren.		Si hubiéren comido.
	Si VV. comiéren.		Si VV. hubiéren comido.

THIRD CONJUGATION.

	Present		*Perfect Indefinite.*
Sing.	Viva, *I may live.*	*Sing.*	Haya vivido, *I may have lived.*
	Vivas.		Hayas vivido.
	Viva.		Haya vivido.
	V. viva.		V. háya vivido.
Plur.	Vivamos.	*Plur.*	Háyamos vivido.
	Viváis.		Háyais vivido.
	Vivan.		Hayan vivido.
	VV. vivan.		VV. hayan vivido.

	Imperfect.		*Pluperfect.*
Sing.	Viviera, viviría, viviese. *I would, should, might live.*	*Sing.*	Hubiéra, habría, hubiese vivido, *I would, should, might have lived.*
	Vivieras, vivirías, vivieses.		Hubiéras, habrías, hubieses vivido.
	Viviera, viviría, viviese.		Hubiera, habria, hubiese vivido.
	V. viviera, viviría, viviese.		V. hubiéra, habria, hubiese vivido.
Plur.	Viviéramos, viviríamos, viviésemos.	*Plur.*	Hubieramos, habriamos, hubiésemos vivido.
	Vivierais, viviríais viviéseis.		Hubiérais, habriais, hubiéseis vivido.
	Viviéran, vivirian, viviesen.		Hubieran, habrian, hubiésen vivido
	VV. vivieran, vivirían viviesen.		VV. hubiéran, habrian, hubiesen vivido.

	First Future.		*Second Future.*
Sing.	Si viviere, *if I should live*	*Sing.*	Si hubiére vivido, *if I should have lived.*
	Si vivieres.		Si hubiéres vivido.
	Si viviere.		Si hubiére vivido.
	Si V. viviére.		Si V. hubiere vivido.
Plur.	Si viviéremos.	*Plur.*	Si hubiéremos vivido.
	Si viviereis.		Si hubiéreis vivido.
	Si vivieren.		Si hubiéren vivido
	Si VV. vivieren.		Si VV. hubieren vivido.

VOCABULARY.

Á las dos, *at two o'clock.*
Á las tres, *at three o'clock.*
Amar, *to love.*
Asunto, *business, matter.*
Beber, *to drink.*
Buscar, *to seek.*
Comer, *to eat, to dine.*
Corréo, *post, mail.*
Cuando, *when.*
Cumplir, *to fulfil.*
Deber, *duty.*
Escribir,* *to write.*
España, *Spain.*
Favor, *favour.*
Hablar, *to speak.*
Hallar, *to find.*
Hasta estonces, *till then*
Leer, *to read.*
Llegar, *to arrive.*
Llevar, *to carry.*
Llorar, *to weep.*
Los Estados Unidos, *the United States.*
Mañana, *to morrow, morning.*
Palabra, *word.*
Permitir, *to permit.*
Quedar, *to remain*
Rehusar, *to refuse.*
Reposo, *repose.*
Responder, *to reply, to answer.*
Terminar, *to terminate, to close.*
Viajar, *to travel.*
Vivir, *to live.*
Ya, *already.*

EXERCISE 30.

Translate into English :—

1. Dios nos ama. 2. Los pintores la aman. 3. El Aleman ama la verdad. 4. Quedan contentos. 5. V. busca reposo. 6. Quedas triste. 7. Habláis el Ingles. 8. El Frances no come pan. 9. Mis hermanos no beben vino. 10. No come V. nada. 11. No beben VV. nada. 12. María escribe cartas. 13. Escribís muchas cartas. 14. V. vive en la ciudad. 15. ¿Cómo halla V. este pan? 16. María lloraba. 17. Pedro hablaba. 18. Las mugeres lloraban. 19. Yo bebía vino. 20. Diego bebía ágna. 21. Yo escribía una carta. 22. Vivías en Madrid. 23. Yo buscaba reposo. 24. Viajó por España. 25. Viajé por los Estados Unidos. 26. Juan lloró. 27. Leí estos libros. 28. Bebimos vino y leche. 29. Escribí dos cartas. 30. Escribieron doce cartas. 31. Le han rehusado ese favor. 32. Juan me ha rehusado ese favor. 33. ¿Has viajado por España? 34. ¿No ha comido V. pan? 35. He comido mucho pan. 36. ¿Ha llegado el juez? 37. ¿Han hallado VV. mis lamparas? 38. ¿Ha viajado V. por los Estados Unidos? 39. Hasta entónces no habiamos terminado nuestros asuntos. 40. ¿No habias vivido ya en]

hallado el tesoro, escribí cartas á mis amigos. 42. Cuando hubimos hablado, nuestras hermanas lloraron. 43. Vijaremos por Inglaterra. 44. Comeré este pan. 45. Comerán manzanas. 46. Escribirán cartas. 47. Mi criado llevará las cartas al corréo. 48. Habrán llegado á las tres. 49. Llorad con los que lloran. 50. Comed este pan. 51. Cumplid vuestras palabras. 52. Come tú conmigo. 53. Come tú con Pedro. 54. Lean las señoras esos libros. 55. Léa V. esa carta. 56. Hable V. Español. 57. No hable V. de eso. 58. No bebas vino. 59. No lloréis. 60. Es posible que halles un tesoro. 61. Es probable que no cumplan sus deberes. 62. ¡Ojalá halléis reposo! 63. Si María llorara, Juan lloraría. 64. ¡Ojalá los hombres cumpliesen sus deberes! 65. Es posible que no hayan hallado un tesoro. 66. ¡Ojalá que yo no hubiese hablado! 67. Si Juan no hubiese hablado, María no habría llorado. 68. Si mañana hallaren un tesoro, nos escribirán 69. Permitame V. leer eso libro. 70. Era preciso hablarles. 71. Estaban comiendo y bebiendo. 72. Habiendo hallado un tesoro en el camino, le llevamos en la casa del abogado.

EXERCISE 31.

Translate into Spanish :—

1. I weep. 2. My mother seeks repose. 3. She does not find repose. 4. They speak. 5. Thou speakest. 6. They weep. 7. Do you (*VV.*) speak Spanish? 8. We speak Spanish. 9. I do not find repose. 10. Thou drinkest wine. 11. I drink water. 12. I eat bread. 13. John reads books. 14. They read books. 15. Repliest thou nothing? 16. We drink wine. 17. Ye drink water. 18. The physician lives in London. 19. My daughters live in the United States. 20. Thou fulfillest thy word. 21. I fulfil my duties. 22. We were carrying much money with us. 23. The ladies were seeking repose. 24. I was weeping. 25. We were eating bread. 26. They were living in London. 27. Ye were living in the city. 28. We were writing letters. 29. The French woman found (perf. def.) no repose. 30. We travelled through England. 31. They found a treasure in the road. 32. I ate bread and butter. 33. They ate sugar. 34. John answered nothing. 35. You (*V.*) lived in Madrid. 36. I have found my treasures. 37. Has the^2 post^3 arrived^1? 38. We have found the spoons. 39. Have ye refused them that favour? 40. I have kept (*cumplido*) my word. 41. They have fulfilled their word. 42. Hast thou eaten much honey? 43. Till then ye had spoken Spanish. 44. They had^2 already^1 eaten^3 when we arrived. 45. Till then they had lived in peace. 46. When thou hadst dined, thy father

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* *Escribir* is irregular in its past participle, having *escrito* and not *escribido*.

arrived. 47. I shall travel through Spain. 48. He will find a treasure. 49. Thou wilt read those books. 50. We shall fulfil our words. 51. I shall have dined at two o'clock. 52. The post will have arrived at two o'clock. 53. Drink ye water. 54. Live ye in peace with all men. 55. Let Mary read my letters. 56. Let men fulfil their duties. 57. Eat (*V.*) some apples and pears. 58. Read (*VV.*) that letter. 59. Do not read this book. 60. Answer ye me. 61. Write ye to them. 62. Write thou to us. 63. It is possible that they may read those books. 64. It is probable that she may not answer him. 65. If I should find books, I would read them. 66. Oh that they would not drink wine! 67. Oh that he would not weep! 68. It was (*era*) necessary that Mary should not speak loud (*alto*). 69. It is possible that he may not have arrived. 70. It was (*era*) strange that they should not have found those books. 71. If Peter^3 should arrive^2 to-morrow,^{1} I will write to thee. 72. Will you (*V.*) permit me to read that letter? 73. John pretends not to have spoken. 74. Having found a book, I am reading it.

REFLECTIVE VERBS

Those verbs are called *reflective* or *reciprocal* which *reflect* the action they express on their nominative, as:—Yo me desnudo, *or* me desnudo, *I undress myself;* el se ahorcó, *or* se ahorcó, *he hung himself;* nosótros nos amamos, *we love ourselves*, or *we love each other*.

The reflective verbs are inflected in the same manner as the verb would be conjugated if it were employed without the reflective pronouns. The verb *ahoroar* is thus conjugated reflectively:—

INFINITIVE MOOD.

	SIMPLE TENSES		COMPOUND TENSES.
Present	—Ahorcárse, *to hang oneself.*	*Past.*	—Habérse ahorcado, *to have hung oneself*
Present Gerund.	—Ahorcándose, *hanging oneself.*	*Past Gerund.*	— Habiéndose ahorcado, *having hung oneself.*
Past Participle.	— Ahorcádo, *hung oneself.*		

INDICATIVE MOOD.

	Present.		*Perfect Indefinite.*
Sing.	Me ahorco, *I hang myself*	*Sing.*	Me he ahorcado, *I have hung myself.*
	Te ahorcas.		Te has ahorcado.
	Se ahorca.		Se ha ahorcado.
Plur.	Nos ahorcamos.	*Plur.*	Nos hemos ahorcado.
	Os ahorcáis.		Os habéis ahorcado.
	Se ahorcan.		Se han ahorcado.

And thus through all the moods and tenses.

It must not be forgotten that the reflective pronouns are always in the objective case, and governed by the verb which comes after them or to which they are joined (for they are always joined to infinitives, gerunds, and imperatives). The nominative personal pronouns are not generally used.

THE PASSIVE VERB.

A passive verb is conjugated by adding to the auxiliary verb *ser*, through all its moods and tenses, the past participle of the verb to be conjugated. The participle in such a case is inflected by gender and number like an adjective. Thus, to say, *he is loved, she is loved, they are loved* (masc.), *they are loved* (fem.), would be—El es amado, ella es amada, ellos son amados, ellas son amadas.

The passive verb formed by *ser* is used in Spanish in the present and imperfect tenses of the indicative mood only when a mental act or state of the emotions is spoken of; thus we can say, ella es amada, *she is loved;* but we cannot say, ella es hallada, *she is found;* since, in the latter case, no state of mind or feelings is described, and the perfect indefinite tense must be employed, thus:—Ella ha sido hallada, *she has been found.* For the past tense of the indicative, when no state or act of the mind is spoken of, the perfect definite must be used, as:—La casa fué (*not* era) quemada, *the house was burnt.*

The passive verb *ser hallado* is thus conjugated:—

INFINITIVE MOOD.

	SIMPLE TENSES.		COMPOUND TENSES.
Present	—Ser hallado, *to be found.*	*Past.*	– Haber sido hallado, *to have been found.*
Present Gerund.	—Siendo hallado, *being found*	*Past Gerund.*	—Habiendo sido hallado, *having been found.*
Past Participle.	—Sido hallado,[*] *been found.*		

INDICATIVE MOOD.

	Present.		*Perfect Definite.*
Sing	Soy hallado, *I am found.*	*Sing.*	Fui hallado, *I was found.*
	Eres hallado.		Fuiste hallado.
	Es hallado.		Fue hallado.
	V es hallado.		V. fue hallado.
Plur	Somos hallados.	*Plur.*	Fuimos hallados.
	Sois hallados.		Fuisteis hallados.
	Son hallados.		Fueron hallados.
	VV. son hallados.		VV. fueron hallados.

	Imperfect.		*First Future*
Sing	Era hallado, *I was found.*	*Sing.*	Seré hallado, *I shall or will be found.*
	Eras hallado.		Seras hallado.
	Era hallado.		Será hallado.
	V. era hallado.		V. será hallado.
Plur.	Eramos hallados.	*Plur.*	Seremos hallados.
	Érais hallados.		Seréis hallados.
	Eran hallados.		Serán hallados.
	VV. eran hallados.		VV. serán hallados.

IMPERATIVE MOOD.

Sing.	Sea hallado, *let me be found*, or *may I be found.*	*Plur*	Seamos hallados, *let us be found*, or *may we be found.*
	Sé hallado, *be thou found.*		Sea hallados, *be ye* or *you found.*
	No seas hallado, *be not thou found.*		No seais hallados, *be not you found.*
	Sea hallado, *let him be found*, or *may he be found.*		Sean hallados, *let them be found*, or *may they be found.*
	Sea V. hallado, *be you found.*		Sean VV. hallados, *be you found.*

SUBJUNCTIVE MOOD.

	Present.		
Sing.	Séa hallado, *I may be found.*	*Plur.*	Seamos hallados.
	Seas hallado.		Seáis hallados.
	Séa hallado		Sean hallados.
	V. sea hallado.		VV. sean hallados.

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[*] *Hallado* means *been found*, as well as *found*, so that *sido* is not used in forming the passive past participle.

Imperfect.

Sing.	Fuera, seria, fuese hallado, *I would, should, might be found.*	*Plur.*	Fuéramos, seriamos, fuésemos hallados.
	Fueras, serias, fueses hallado.		Fuérais, seriais, fuéseis hallados.
	Fuera, seria, fuese hallado.		Fueran, serian, fuesen hallados.
	V. fuera, seria, fuese hallado.		VV. fueran, serian, fuesen hallados.

First Future.

Sing.	Si fuere hallado, √ *I should be found.*	*Plur.*	Si fuéremos hallados.
	Si fueres hallado.		Si fuéreis hallados.
	Si fuere hallado.		Si fueren hallados.
	Si V. fuere hallado.		Si VV. fueren hallados.

The compound tenses of the passive verb are formed by the several simple tenses of *haber* and the passive past participle of the verb to be conjugated, as:—

He sido hallado, *I have been found.*
Habia sido hallado, *I had been found.*
Habré sido hallado, *I shall have been found.*
Si hubiere sido hallado, √ *I should have been found*

Se and the other personal pronouns of the first objective case are often used in Spanish with neuter or active intransitive verbs, and in such cases seem redundant in English, as:—V. se burla, *you jest;* mucho me alegro, *I rejoice much;* se caerá VV., *you will fall.* Those verbs designated with an asterisk (*) in the vocabulary are thus used.

VOCABULARY.

Acercarse,*	*to approach, to draw near.*
Á las seis,	*at six o clock.*
Á las siete,	*at seven o clock.*
Alabar,	*to praise.*
Alegrarse,*	*to rejoice.*
Armar,	*to arm.*
Bien,	*well, properly.*
Burlarse,*	*to jest.*
Esconder,	*to hide*
Invierno	*winter*
Juntarse,*	*to assemble*
Levantar,	*to raise;* levantarse, *to rise*
Mal,	*badly, improperly.*
Meterse,*	*to meddle, to interfere*
Pais (m.),	*country, region*
Portarse,*	*to behave, to conduct oneself*
Primavera,	*spring*
Quejarse,*	*to complain.*
Retirarse,*	*to retire, to withdraw.*
Salvar,	*to save.*

EXERCISE 32.

Translate into English —

1. ? Cómo se halla V.? 2. Los abogados se portan mal. 3. Os portáis mal 4 El carpintero se halla contento. 5. Pedro se alabó 6 El general se armó. 7. Se salvaron. 8. Me escondí. 9. Nos escondimos. 10. ¡Ojalá me hallase con ella! 11. Tus amigos se juntarán en Lóndres. 12. Alabáos. 13. Armémonos. 14. Armese V. 15. Me alegro mucho. 16. Se acerca el invierno. 17. V. se burla. 18. Pedro se queja. 19. ¿De quién se quejan? 20. Siempre me levanto á las seis. 21. ¿No se retiraría V. del pais? 22. Se alegran. 23. Alegráos. 24. Alégrense. 25. No se queje V. 26. No nos metamos en los asuntos del juez.

EXERCISE 33.

Translate into Spanish:—

1. Peter behaves himself well. 2. Thou behavest thyself well? 3. They assembled (themselves) in Madrid. 4. Thou lovest thyself. 5. The woman hid herself. 6. My^{3} brothers^{4} praise^{2} themselves^{1}. 7. I praise myself. 8. We arm ourselves. 9. They have behaved themselves badly. 10. Oh that they would conduct themselves well! 11. Hide thyself. 12. Save yourselves. 13. Praise yourself. 14. Thou jestest. 15. The^{2} spring^{3} approaches^{1}. 16. They complain. 17. Thou rejoicest. 18. You^{3} (*V.*) have^{1} risen^{2}. 19. Have I ever (*nunca*) meddled in your (*de V.*) affairs (*asuntos*)? 20. I will retire.

COMPARATIVE ANATOMY.—X.

[*Continued from p.* 315.]

INSECTA (*continued*).

ONE thing should be noted in this ordinal arrangement which otherwise might perplex the student. The Dragon-fly family, with its nearly allied families of the Ephemeridæ (May-flies) and the Perlidæ, are transferred from the Neuroptera to the Orthoptera on account of their having a free prothorax. Now the dragon-fly was once considered to be the very type of a neuropterous insect, and it seems probable that Linnæus intended that it should be the type of the order he constituted; nevertheless, it is certain that the dragon-flies and the may-flies show a nearer relationship to the Orthoptera than the rest of the so-called Neuroptera.

The Hemiptera are so named from the fact that many of them have their fore wings distinctly divided into two parts; the anterior and outer half being horny, like the wing-cases of a beetle, while the inner and hind half is membranous, like the wing of a bee.

As this peculiarity only belongs to one large division of the order, some naturalists have given to it the name *Rhynchota*, or beaked insects, on account of the long rostrum or sucking snout which is found in every member of the order.

The order is divided into two tribes, the *Homoptera* and the *Heteroptera.* It is in the Homoptera (like-winged) that the wings are of the same consistency throughout. One of the largest and most celebrated of these insects is shown in the illustration. The insect represented is the female. The male is larger, and is furnished underneath with two large plates covering in a musical apparatus, which it plies most vigorously both during the day and night. The writer took this insect in Italy, where it abounds, and has been known since classical times. The ancients called the cicada happy, because it had a dumb wife. The cochineal insect, the aphides—whose periodical presence in vast multitudes on plants is commonly called a *blight*—the Chinese lantern-fly, and the froghopper, all belong to this sub-order. Lice and bird-lice

(Pediculina and Mallophaga) may also be considered to be aberrant families of this sub-order, though some have made separate orders for each of them.

The Heteroptera (unlike-winged) have wings such as have been described as giving their name to the Hemiptera. The insect marked 2 in the illustration may be given as a type of this sub-order. The water-scorpion, the water-boatman, and the hydrometra each represent families of this sub-order. The last-named is represented in the engraving. It may be seen skating over the surface of every piece of water in summer and autumn.

The Diptera may be divided into the flies proper and two aberrant families. The lowest of these families is well known to us, being represented by the almost ubiquitous flea. The mouth-organs of this insect are very different from those of the genuine flies, and in the place of wings they have only four scales, which appear to be quite useless. Nevertheless, they seem from their metamorphosis, and for other reasons, to be more nearly allied to the Diptera than to any other order.

The genuine flies may be divided into two great divisions, one of which, the Brachycera (short-horned), have short antennæ composed of three joints, while the palpi are of one or two joints; the other sub-order, named Nemocera (thread-horned), have their whip-like antennæ (sometimes beaded) in many joints, while the maxillary feelers are four- or five-jointed. The antennæ also often have fine secondary hairs springing from each joint, which gives them the appearance of a plume. This, in the common gnat, is a very pretty object. The common daddy-longlegs (Tipula) is a good example of this order. Both of the flies in the illustration belong to the Brachycera. The hornet-fly is one of the largest of our British Diptera, and while in flight is very like the insect from which it derives its specific name.

The Lepidoptera have been variously divided into groups. The sub-order Macrolepidoptera includes the day-flying butterflies with knobbed antennæ, the hawk-moths (Sphingidæ), the thick-bodied moths (Bombycidæ), the Noctuæ, and the loopers (Geometridæ); while the other sub-order, Microlepidoptera, comprises the pearl-moths (Pyralidæ), the bell-moths (Tortricidæ), the cloth-moths (Tineina), and the plume-moths (Pterophoridæ). The moth in the engraving belongs to the Noctuæ, and is called Euclidia on account of the pattern of geometrical figures formed by the coloured scales of the wings.

The *Hymenoptera* are divided into the Aculeate, or stinging; the Entomophagous, or insect-eating; and the Phytophagous, or plant-eating, sub-orders. Some species of the latter sub-orders can prick, but the Aculeata are those which have a perforated sting leading from a poison-bag. The males of these have thirteen joints, and the females twelve joints to their antennæ. The abdomen is connected with the thorax by a very thin stalk. The females, or workers, usually feed the larvæ or grubs, which are walled up in cells. The bee, the wasp, and the ant each represent different families of this order.

In the entomophagous Hymenoptera, the females are furnished with an ovipositor, placed between two side-plates, which are usually stretched freely out from the end of the abdomen, and are often of great length. This complex instrument is made use of to insert the eggs deep into the bodies of the larvæ of other insects, in the abdominal cavity of which the footless larvæ live parasitically, and there change into pupæ. Hence the enthusiastic lepidopterist who breeds his moths from caterpillars is often woefully disappointed by having a brood of ichneumon-flies emerge from the chrysalis, whose once living tenant they have entirely consumed. No. 8 in the illustration represents an entomophagous insect. In the phytophagous Hymenoptera, the abdomen is joined to the thorax by its whole width and not by a stalk. These insects are called saw-flies, because they are furnished with a double saw at the end of the body, with which they saw into wood, and there deposit their young, which, when hatched, are herbivorous.

The beetles (Coleoptera) form a well-defined order, none of the families of which can be called aberrant—that is, they cannot be said to stray far away from the true beetle type. The main divisions of the beetles have been founded on the number of the joints of the foot below the tibia. Thus the Pentamera have five joints to all their feet; the Heteromera have four joints to the feet of the third pair of legs, and five to the others. The Cryptopentamera have *apparently* four joints to all their feet. This appearance is occasioned by the great reduction in size, or, as it might be called, the abortion of one of the joints of each foot. The Trimera, similarly, have apparently three-jointed feet. Both the beetles in the engraving belong to the Pentamerous division. The Cicindela is a carnivorous beetle, and the Geotrupes is an herbivorous lamellicorn—*i.e.*, the last joints of the antennæ are produced into flat, appressed plates.

The Neuroptera, narrowed by the transference of the dragon-flies and the may-flies to the Orthoptera, are divided into the *Planipennia*—in which the hind wings are like the fore ones, and not folded—and the *Trichoptera*, in which the wings are hairy or scaly and the hind pairs folded. To these divisions, also, must be added the aberrant sub-order, called Strepsiptera (screw-winged). The males of these have curious twisted and aborted organs to represent the fore wings and widely expanded hind wings; while the females are wingless, and inhabit the bodies of bees, between the segments of whose abdominal rings they thrust forth their heads.

The Orthoptera, as defined above, comprise not only the genuine Orthoptera represented by the cockroaches, walking-leaves, grasshoppers, and crickets—whose main characteristic is the folding of their broad hind wings longitudinally, after the manner of a lady's fan—but also the white ants, the earwigs, and dragon-flies, etc., and also two aberrant groups, called Physopoda and Thysanura. The earwigs (Dermaptera) are distinguished by their short, leathery, unveined elytra or fore wings, which cover the membranous hind wings. These latter are folded when at rest, first in a longitudinal direction, and then doubled up transversely, so as to occupy but little space. When extended, these membranous wings are in shape like the human ear, hence the name ear-wing, and its corruption earwig. The pincers at the end of the body, the uses of which are so little known, furnish another character which is conspicuous to all. Two more aberrant sub-orders, the Corrodentia and Physopoda (bladder-footed), are of little importance. Another, which would be better placed in a separate group, as some entomologists have suggested, is called the Thysanura, and is remarkable for having long bristles at the end of the body, which in the Podura are bent under the body, and serve as springs to jerk the insect into the air when it wishes to leap, much after the manner of the toy leaping-frog. These creatures have their bodies covered with scales, which are so small yet so beautifully symmetrical in their markings as to make excellent test objects for the high powers of a microscope.

The tribe to which the white ants belong is called *Orthoptera socialia*, because they live in communities. Although they belong to quite a different order from the true ants, yet the popular name is justified by the fact that their habits are mostly similar to them. It is a singular coincidence that in both the cases of the true and the white ants, there are not only males and females in the community, but also neutral wingless forms, which, though themselves sterile, are highly instrumental in presiding over the reproduction and rearing of the young from the other fertile forms, and also in the defence of the nest and community. In the case of the Termites, the neuters are called soldiers, because of their immense jaws, wherewith they attack all intruders. The larvæ and pupæ are active, and do the work of the community. The female has wings which have only a temporary use. When pregnant, she is placed in a royal apartment, and fed while she increases to an enormous size, preparatory to the production of some 80,000 eggs.

The Praying Mantis is a good example of another family. The cognomen is applied on account of the bent fore legs of the animal, which are supposed to represent the attitude of prayer. The mantis, however, uses them to inflict painful wounds by the aid of the sharp-pointed tibiæ.

ECHINODERMATA (HEDGEHOG-SKINNED ANIMALS).

From the earliest times, before Aristotle wrote of animals, the great similarity in outward appearance between the hedgehog, when rolled up in self-defence, and the sea-egg, or echinus, has been so recognised as to cause them to be called by the same name. In Greek, echinus (ἐχῖνος) means both the one and the other.

The shell of a typical echinus, upon which the spines are set, is a round box of very complex and beautiful structure. It consists of plates of carbonate of lime so closely and accurately fitted together that, even after the spines have been stripped off, it requires minute examination to discover the lines of division between them. The box has the form of a more or less depressed sphere, varying from the shape of a true globe to that of a Turkish turban. At each pole of the box there is a hole: that which opens on the under side of the animal is the mouth, while that which is found at the centre of the top side is the vent. A further examination reveals that the shell is made up of five similar radial divisions, which stretch from pole to pole, and may be thus described:—The central zigzag line, running from mouth to anus, has on either side of it a row of small plates alternating with one another; and on the outer side of each of these rows of plates is a row of small holes. There are six of these holes in each plate. Externally to these perforated plates are situated two other rows of larger plates, one on each side, and these are united at their external edges to the next radial division of the box by a zigzag line. The outer side of both the perforated plates and the plates without holes are covered with bosses, each of which has a more prominent rounded knob projecting from the top of it, which knob has a pit in its centre. These knobs bear the spines. They are of various sizes, but so arranged as to form a beautifully regular pattern; for each plate has at its centre a large boss, and, as the plates are regularly placed one above the other, there are, on the whole shell, twenty rows of these tubercles running from top to bottom, set on lines which correspond to the meridians of a globe. Yet, if the reader has followed the description, he will see that these rows are not all at equal distances from one another, for those on the smaller perforated plates are approximated, while those of the larger plates are removed from one another; nor are the tubercles of the several rows all at the same distance from each other. Besides these tubercles, a great many others of various sizes lie between the rows.

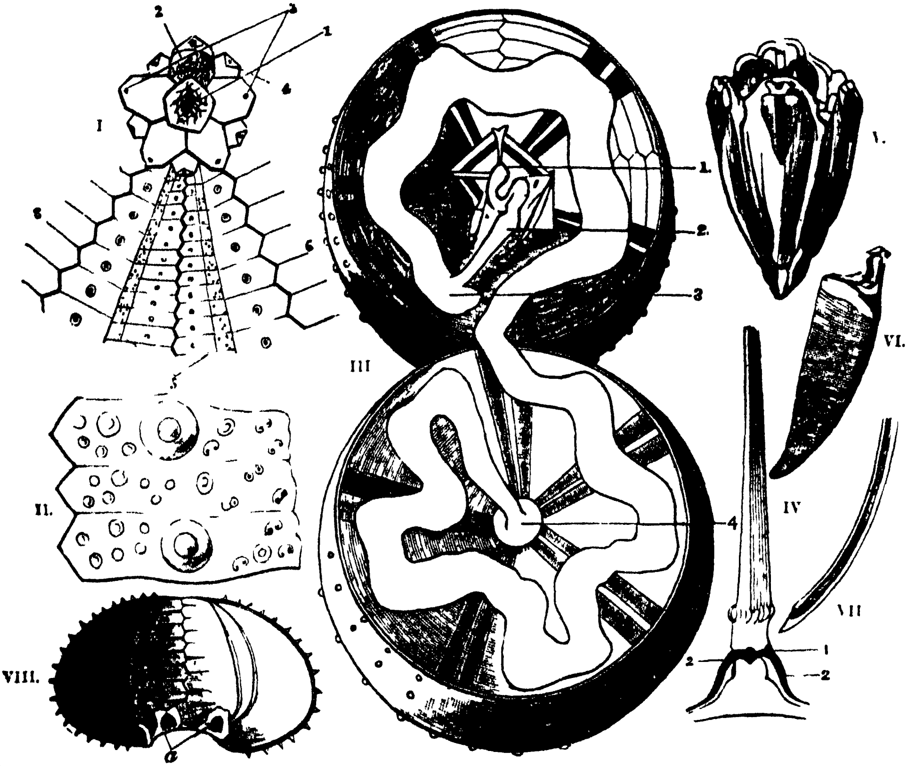

Fig 82.—I. Diagram showing the plates and holes on the upper side of an Echinus Shell. II. Ambulacral Plates enlarged. III. Echinus divided in the equatorial region to show Alimentary Canal. IV. Spine, with section of its Tubercle. V. Jaws and Teeth which, united, are called the "Lantern of Aristotle." VI. Side view of a Single Jaw. VII. Its Tooth. VIII. Inside of the Purple-tipped Sea-Urchin, showing the Calcareous Loops (a)

Refs. to Nos. in Figs.—I. 1, anal hole, 2, madreporic plate; 3, genital plates with their pores; 4, ocular plates and pores; 5, ambulacral tracts and holes, 6, interambulacral or imperforate plates. III. 1, base of jaws, 2, gullet, 3, commencement of stomach; 4, anus. IV. 1, pit ligament; 2, annular muscle.

The ten perforated tracts which, being arranged in pairs, form five double bands or courses, converge towards the mouth and anus. The regularity of these tracts, converging at both ends and leaving between them a solid tract, has suggested a fanciful analogy. They were thought to resemble the gravel walks of our gardens, with their borders or avenues of trees on each side, and so were called ambulacra; *ambulacrum* being a post-classical Latin word, meaning a garden walk. At the point where the two converging perforated tracts unite is a single six-sided solid plate, which has at its side nearest the ambulacra a hole from which the ambulacral holes seem to diverge. The five perforated hexagonal plates which thus stand at the end of the ambulacral avenues are separated from one another and from the top opening by five other irregular eight-sided plates which surround the small movable scales which cover in the anus. As far as our previous description has gone, the reader will perceive that all parts are perfectly radial. The five segments are absolutely alike; but one of the eight-sided plates has, between the large pore and the anus, a space which is perforated by a number of holes, and in this respect it differs from all the other five plates of the series, and is called the madreporic plate. At the other pole of the body there is a large opening covered by a leathery membrane, in the centre of which is the mouth. Placing the animal with its mouth downwards, which is the position it usually occupies, and looking at it from above, let us enumerate the perforations which we have described, beginning from the centre at top, and proceeding outward and downward, so that all confusion may be avoided. We have the following different series:—

1. The central round opening, which is covered by small movable calcareous pieces, the anus or vent.

2. On one side of this are the minute crowded holes of the madreporic plate.

3. In the five plates which surround the apical hole are the five holes, each of which occupies the external angle of its plate; these are called the generative pores.

4. In the five plates which are intermediate to and outside these the ocular holes are seen.

5. Stretching away in five double tracts are the ambulacral holes.

6. The large opening below for the mouth and its membrane.

We are now in a position to indicate the relation of the soft parts of the animal to this protective box. All the above-named perforations have their uses; and a study of these will teach us almost the whole anatomy of the animal.

The alimentary canal connects the two largest holes which lie in the vertical axis of the body. The entrance, or mouth, is in the centre of the wide orifice in the under side, which is covered in by a leathery membrane, with the exception of where the pointed teeth project. The curious beak, composed of five sharp teeth, forms a very effective instrument wherewith the animal can scrape away the soft calcareous rocks in which so many worms and sea-animalcules bore and hide themselves; its structure is too complicated to allow of a full description here.

The food canal does not run in a straight line from mouth to anus, but, after proceeding a short way as a contracted throat, opens sideways into a wider canal, which, after winding once round the inside of the shell, is bent on itself, and winds round back again, and then delivers at the vent. This winding enables the food to undergo a more thorough digestion, while the nutritive parts of the food are dissolved, and either pass into the blood-vessels, which are found in the walls of the intestines, or into the surrounding cavity. It must not be supposed that this long alimentary canal is loose in the box, only attached by its two extremities. If so, it would be liable to become entangled. It is attached by a membrane which lines the inner surface of the shell, and then passes off from this round the alimentary tube, so as to hold it in a loop, or rather fold. This arrangement is very general, not only in these, but in the higher animals.

The holes in the five larger plates surrounding the anal opening are those through which the generative products are extruded into the sea-water, so to renew the round of life. They furnish the exits for five separate organs situated just below them. The holes in the alternate plates are called ocular holes, because through them a nerve passes to an organ supposed to be an eye. The ambulacral holes and the madreporic holes need a further explanation, which will lead to a description of the locomotive organs of the animal. The locomotive organs of the echinus are of two kinds—the soft for pulling, and the hard for pushing. The hard-pushing organs are the spines. These are, no doubt, defensive organs, but they also unite with this function that of locomotion. The spines are, as we have said, set upon the knobs of the outside of the shell. They are, however, movable upon these, so that they can be turned in all directions. The shell is not naked, but covered with irritable and live membrane, which membrane passes down between each plate, and, no doubt, subserves the function of secreting fresh matter round the edges of these plates as the animal grows. How far the spines may aid the animal in progression may be a matter of question; but those who have observed its motion believe they are concerned in it. By far the most efficient organs of locomotion are the little tubular feet ending in discs, which are protruded through the ambulacral holes. These feet act like suckers when applied to the rock on which the animal moves. The coatings of circular and longitudinal muscles which enclose the hollow tubes are sufficient to move the animal when a multitude of these discs have been extended and attached; but the question arises, how are they protruded? This is done by a curious contrivance. Each little tube, after traversing the shell and arriving at the interior, expands into a muscular bag. Both bag and tube contain liquid All the little bags, set on each line of ambulacra, communicate with a vessel which stretches from mouth to anus, and these ten vessels all communicate with a ring round the mouth, which ring has opening into it some larger bladders to contain a reservoir of water, and it also communicates with the madreporic holes by a tube, which is filled with fine sand. The method of protruding the tubular feet is supposed to be the following: sea-water is filtered through the madreporic plate and sand canal to the ring round the mouth. When the animal is in a lively state and inclined for locomotion, the bladders force the water into the rows of little bags, and these being muscular, can, by contracting, force out any or all of the sucking feet at pleasure. When, on the other hand, the animal wishes to retract all its feet, the bags, distended by receiving all the water which was in the tubes when extended, would be in an awkward state of tension unless the fluid were allowed to pass back into the ring and bladders.

GERMAN.—XLII.

[*Continued from p.* 321.]

THE NOUN (*continued*).

Rule.—Many compound verbs, particularly those compounded with er, ver, ent, an, ab, auf, bei, nach, vor, zu, and wider, require after them the dative, as:—Ich habe ihm Geld angeboten, I have offered him money.

Rule.—An adjective used to limit the application of a noun, where in English the relation would be expressed by such words as *to* or *for*, governs the dative, as:—Sei deinem Herrn getreu, be faithful to your master.

Observations.—Under this rule are embraced (among others) the following adjectives:—ähnlich, like; angemeſſen, appropriate; angenehm, agreeable; anſtößig, offensive; bekannt, known; beſchieden, destined; eigen, peculiar; fremd, foreign; gemäß, according to; gemein, common; gewachſen, competent; gnädig, gracious; heilſam, healthful; lieb, agreeable; nahe, near; überlegen, superior; willkommen, welcome; widrig, adverse; dienſtbar, serviceable; gehorſam, obedient; nützlich, useful.

Rule.—A noun or pronoun which is the *immediate* object of an active transitive verb is put in the accusative, as:—Der Hund bewacht das Haus, the dog guards the house.

Observations.—(1) The accusative, as before said, being the case of the *direct* or *immediate* object, is used with all verbs (whatever their classification in other respects) that have a *transitive* signification. Accordingly, under this rule come all those impersonal and reflective verbs that take after them the accusative; all those verbs having a *causative* signification, as:—Fällen, to fell, *i.e.*, to *cause* to fall; as also nearly all verbs compounded with the prefix be-. The exceptions are begegnen, behagen, beſtehen, beruhen, beharren, and bewachſen.

(2) Lehren, to teach; nennen, to name; heißen, to call; ſchelten, to reproach (with vile names); taufen, to baptise (christen), take after them *two* accusatives, as:—Er lehrt mich die deutſche Sprache, he teaches me the German language; er nennt ihn ſeinen Retter, he calls him his deliverer.

(3) The accusative is used with such terms as wiegen, to weigh; koſten, to cost; gelten, to pass for; werth, worth; ſchwer, heavy; reich, rich; lang, long; weit, wide, to mark definitely the *measure* or *distance* indicated by these words, as:—Dieſer Stock iſt einen Fuß lang, this stick is a foot long; er iſt vier Monate alt, he is four months old. In the earlier German these words of measure or distance were put in the genitive, as:—Einer Spanne weit, a span wide.

(4) As words expressing time indefinitely are put in the genitive, so those denoting a particular point or duration of time are put in the accusative, as:—Ich wartete zwei Tage, I waited two days.

Rule.—A noun or pronoun used merely to explain or specify that which is signified by a preceding noun or pronoun is said to be in apposition, and must be in the same case, as:—Cicero, ein großer Redner, Cicero, a great orator; der Rath meines Bruders, des Rechtsgelehrten, the advice of my brother, the lawyer.

Observations.—The proper names of months, countries, towns, and the like appellatives, are put in apposition with their common names, where in English the two words stand connected, for the most part, by the preposition *of*, as:—Der Monat Auguſt, the month (*of*) August; die Stadt London, the city (*of*) London; die Univerſität Oxford, the University (*of*) Oxford.

THE PRONOUNS.

Rule.—A pronoun must agree with the noun or pronoun which it represents in person, number, and gender, as:—Der Mann, welcher weiſe iſt, the man who is wise; die Frau, welche fleißig iſt, the woman who is diligent; das Kind, welches klein iſt, the child that is small.

Observations.—(1) The neuter pronoun es is used in a general and indefinite way to represent words of all genders and numbers, as:—Es iſt der Mann, *it* is the *man*; es iſt die Frau, *it* is the *woman*; es iſt das Kind, *it* is the *child*; es ſind die Männer, they are the *men*, etc. In like manner, also, often are used the pronouns das (*that*), dies (*this*), was (*what*), as also the neuter adjective alles (*all*), as:—Das ſind meine Richter, these are my judges.

(2) When the antecedent is a personal appellation formed by one of the diminutive (*neuter*) terminations -chen and -lein, the pronoun, instead of being in the neuter, takes generally the gender *natural* to the person represented, as:—Wo iſt Ihr Söhnchen? iſt er (*not* es) im Garten? where is your little son? is *he* in the garden? The same remark applies to Weib (*woman*) and Frauenzimmer (*lady*). When, however,

a child or servant is referred to, the neuter is often employed.

(3) A collective noun may in German, as in English, be represented by a pronoun in the *plural* number, as:—Die Geiſtlichkeit war für ihre Rechte ſehr beſorgt, the clergy were very anxious about their rights.

(4) The relative in German can never as in English be suppressed. Thus, in English we say, "The letter (*which*) you wrote"; but in German it must be, Der Brief, welchen du ſchriebſt.

(5) The neuter pronoun es at the beginning of a sentence is often merely expletive, and answers to the English word "there" in the like situation, as:—Es war Niemand hier, there was no one here; es kommen Leute, there are people coming.

(6)* The English forms, "he is a friend *of mine*," "it is a stable *of ours*," etc., cannot be literally rendered into German, for there we must say, Er iſt mein Freund, he is my friend; or Er iſt einer meiner Freunde, he is one of my friends; etc.

(7) The definite article in German is often used where in English a possessive pronoun is required, as.—Er winkte ihm mit der Hand, he beckoned to him with his (*the*) hand.

(8) The datives of the personal pronouns are often in familiar style employed in a manner merely expletive, as:—Ich lobe mir den Rheinwein, I like Rhenish wine *for me* or *for my part* (*i.e.*, I prefer Rhenish wine).

THE ADJECTIVES

Rule.—Adjectives, when they *precede* their nouns (expressed or understood), agree with them in number, gender, and case, as:—Dieſe ſchöne Dame, this handsome lady; ein gütiger und gerechter Vater, a good and just father; den zwölften dieſes Monats, the twelfth (*day*) of this month; etc.

OBSERVATIONS.—(1) This rule, of course, has reference to those adjectives which are used *attributively;* for predicative adjectives, it will be remembered, are not declined.

(2) This rule applies equally to adjectives of all degrees of comparison, as:—Beſſere Bücher, better books; der beſte Wein, the best wine; des beſten Weines, of the best wine; etc. So, too, it applies equally to all classes of adjectives—as adjective pronouns, numerals, and participles.

(3) The word "one," which in English so often supplies the place of a preceding noun after an adjective, cannot be translated *literally* into German, its office being rendered needless in the latter tongue by the terminations of declension.

(4) So, also, the English "one's" is a proper equivalent of the German ſein in such cases as the following:—Gibt es etwas Edleres, als ſeinen Feinden zu vergeben? is anything more noble than to forgive one's enemies?

(5) When the same adjective is made to refer to several singular nouns differing in gender, it must be repeated with each and varied in form accordingly, as:—Ein gelehrter Sohn und eine gelehrte Tochter, a learned son and a learned daughter. The adjectives are also often repeated, though the nouns be all of the same gender.

THE VERBS

Rule—A verb must agree with its subject or nominative in number and person, as:—Jeder Augenblick iſt koſtbar, every moment is precious; die Bäume blühen im Frühling, the trees bloom in spring.

OBSERVATIONS.—(1) When the subject is the pronoun es, das, or dies used indefinitely, the *predicate*, if a noun, determines the number and person of the verb, as:—Es ſind die Früchte Ihres Thuns, these are the fruits of your actions.

(2) In the *second* person (singular and plural) of the imperative mood, the pronoun which forms the subject is commonly omitted, as:—Gehet hin und ſaget Johanni wieder, was Ihr ſehet und höret, go and tell John what ye see and hear.

(3) When the verb has two or more singular subjects connected by und, it is generally put in the plural, as—Haß und Eiferſucht ſind heftige Leidenſchaften, hatred and jealousy are violent passions.

(4) When the subject is a collective noun—that is, one conveying the idea of many individuals taken together as unity—the verb must (generally) be in the singular, as—Das engliſche Volk hat große Freiheit, the English people have (*has*) great liberty. In a few cases only (as ein Paar, a pair; ein Menge, a number; ein Dutzend, a dozen), the verb sometimes stands in the plural.

(5) When the verb has several subjects, and they are of different persons, the verb agrees with the first rather than the second, and the second rather than the third, as:—Du, dein Bruder und ich wollen ſpazieren gehen, thou, thy brother, and I will go take a walk; du und dein Bruder vermöget viel, you and your brother avail much.

USES OF THE TENSES.

Rule—The *present tense* properly expresses what exists or is taking place at the time being, as:—Die wahre Tapferkeit beſchützt den Schwachen, true valour protects the weak.

OBSERVATIONS.—(1) The present in German, as in other languages, is often in lively narrative employed in place of the imperfect, as:—Die Sonne geht (*for* ging) unter, da ſteht (*for* ſtand) er am Thor, ꝛc., the sun goes down, when he stands at the gate, etc.

(2) The present is not unfrequently used for the

future, when the true time is sufficiently clear from the context, or when, for the sake of emphasis, a future event is regarded and treated as already certain, as :—Ich reiſe morgen ab, I start (that is, *will* start) to-morrow; dies Schloß erſteigen wir in dieſer Nacht, this castle scale we (that is, *will* we scale) this very night; bald ſehen Sie mich wieder, soon you (*will*) see me again; wer weiß, wer morgen über uns befiehlt, who knows who commands (that is, *will* command) us to-morrow?

(3) It should be noted that the present is, moreover, the proper tense for the expression of general or universal truths or propositions, as :—Die Vögel fliegen in der Luft, birds fly in the air.

(4) In English we have several forms of the present tense, as :—*I praise, I do praise*, or *I am praising*. In German there is but one form (ich lobe) for the expression of these several shades of meaning.

(5) The present, in connection with the adverb ſchon (already), often supplies the place of a perfect, as :—Wir wohnen ſchon ſieben Jahre hier, already dwell we here (that is, *have we dwelt*) seven years.

(6) In English we say often "I *do* walk," "I *did* walk," and the like, where the verb *do* (present and imperfect) is employed as an auxiliary. This cannot properly be done with the corresponding verb (thun, to do) in German.

Rule.—The imperfect tense is used to express what existed or was taking place at some past time indicated by the context, as :—Ich ſchrieb an Sie, als ich Ihren Brief erhielt, I was writing to you when I received your letter.

OBSERVATIONS.—(1) The imperfect is the historical tense of the Germans. Its proper office is to mark what is incomplete, or going on, while something else is going on. It is the tense adopted by the narrator, who speaks as an eye-witness; though it may be used by such as have not been eye-witnesses of the events narrated, provided the statement be introduced or accompanied by such expressions as *he said* (ſagte er), *it is said*, or *they say* (ſagt man) When the speaker has not been an eye-witness, the perfect should be used.

(2) From the use of the imperfect in expressing the continuance of a thing (*i.e.*, what was going on at a given time) comes the kindred power which it has of expressing repeated or customary action, as :—Er pflegte zu ſagen, he used to say, *i.e.*, was in the habit of saying.

Rule.—The perfect tense is that which represents the being, action, or passion as past and complete at the time being, as :—Die Schiffe ſind angekommen, the ships have arrived; er iſt vorige Woche geſtorben, he died last week.

OBSERVATIONS.—(1) The German perfect, as a general thing, corresponds closely to our imperfect when used as an aorist—that is, when used to express an event simply and absolutely, and without regard to other events or circumstances. Hence it often happens, that where in English we use the imperfect, the Germans employ their perfect, thus :—Ich habe deinen Bruder geſtern geſehen, aber nicht geſprochen, I *saw* your brother yesterday, but *did* not speak to him.

(2) The auxiliary participle (worden) in the perfect passive is sometimes omitted.

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"bacteria" as a synonym for the division known to botanists as the Schizomycetes or fission fungi. The **fact that bacteria** multiply by repeated division justifies the application of this term, derived as it is from two Greek words *σχίζω, to split*, and *μυκης, a fungus*. The word bacterium means a little rod, and was at one time reserved for certain members of the group of Schizomycetes, but as already stated the whole group is now commonly spoken of as bacteria. The bacteria are single cells; an idea of their size may be obtained from a study of the plate, noting the magnifying power employed. They may assume various shapes (*see* Plate). There are spherical forms known as "micrococci;" two of these may adhere together forming a dumb-bell shaped double coccus or "diplococcus;" rod-shaped forms are called "bacilli" (*bacillus*, a little staff); intermediate forms between cocci and bacilli, *i.e.* short rods, used to be called, and are still spoken of, as "bacteria"; and thus, as already incidentally observed, this word is unfortunately used in a double sense. Again several rods may adhere together forming filaments known as "Leptothrix" forms, while chains of micrococci are spoken of as "streptococci."

Figs. 1 and 2.—TUBERCLE BACILLUS.
From a photograph by E. C. Bousfield, Esq.)

Curved rods also occur, as, for instance, in the organism known as Koch's cholera bacillus, and if several such curved bacilli are united, end to end, the resulting spiral form is known as spirillum, while a long and closely wound spiral is called a spirochæta.

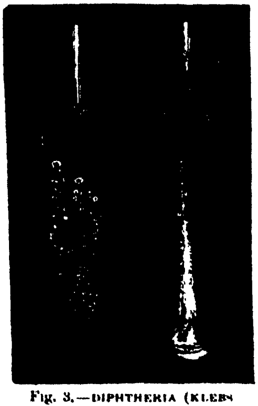

Fig. 3.—DIPHTHERIA (KLEBS LOFFLER).
Fig. 4.—STREPTOCOCCUS PYOGENES.
(*From a photograph by E. C. Bousfield, Esq.*)

Some bacteria are provided with a whip-like "flagellum," which gives them the power of active movement, others are non-motile. Very near relations of the bacteria are met with in certain humble members of the great family of algæ or seaweeds. These lowliest algæ are, like the bacteria, unicellular, devoid of sexual organs, and present many other points of similarity, but one great difference, namely, that they contain the peculiar green colouring matter known as chlorophyll. The absence of chlorophyll in bacteria prevents their obtaining carbon from carbonic acid gas, and they must therefore live upon ready-formed carbon compounds, such as exist in animals or plants. In other words, the bacteria are parasitic, feeding upon organic matter, and in some cases actually attacking living organisms. It is this last peculiarity which attaches such vast importance to the study of bacteria, and the researches of Pasteur and others, which have shown how the life history of fission fungi is bound up with certain fermentations, with putrefaction, and finally with disease, gave a powerful impetus to the scientific study of these minute plants, which are now recognised to be fraught with the most wonderful power for working good or ill to higher forms of life.

The importance of the study of bacteria, then, was first recognised in investigating the *rôle* played by them in fermentation processes. Pasteur showed that milk turns sour because of the growth within it of a bacterium, which converts the sugar of milk into lactic acid; again, in the manufacture of vinegar a bacterium is at work, and is the cause of the conversion of alcohol into acetic acid. After the establishment of these facts the question arose whether the phenomena of putrefaction might not also be due to bacterial growth, and this led to a great controversy. It was maintained, on the one hand, that bacteria could never develop in nutrient material unless similar bacteria already existed there, or were introduced from without; on the other hand, the doctrine of spontaneous generation was upheld, and it was urged that it was impossible to prevent putrefactive processes from occurring in organic infusions, however carefully they were preserved from bacterial intrusion. The difficulty was not easily set aside, so small were the living units in question and so universal is their distribution; their minute spores are readily borne from place to place by currents of air, and every drop of water teems with bacterial life. It was found, however, in course of time that prolonged boiling was uniformly effectual in destroying all germs, and that nutrient material which had been exposed to this treatment in flasks plugged with cotton wool could be kept for an indefinite period without undergoing putrefactive changes. The cotton-wool plug served the purpose of a filter, permitting interchange of gases between the inside of the flask and the outer world, but preventing any organisms reaching the interior of the flask from outside. Nutrient media which have thus been prevented from putrefying are said to be "sterilised;" that their remaining unchanged is due to the absence of bacterial life within them is easily shown by noting the effect of introducing germs into them from without. Such sterile media are now largely employed in studying the growth of bacteria, and

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